LIBRARY NAVAL POSTGRADUATE SCHOOL
MONTEREY CA 93940

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

THE WARRANTY GUARANTY CLAUSE:
AN ANALYSIS OF ITS USE ON THE SPRUANCE
CLASS (DD-963) SHIPBUILDING CONTRACT AND
IDENTIFICATION OF LESSONS LEARNED

by

James T. Freihofer

and

Daniel S. Beach

March 1983

Thesis Advisor: D. C. Boger

Approved for public release; distribution unlimited

T207922

LIBRARY, NAVAL POSTGRADUATE SCHOOL
MONTEREY, CA 93940

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle) The Warranty Guaranty Clause: An Analysis of its Use on the Spruance Class (DD-963) Shipbuilding Contract and Identification of Lessons Learned

5. TYPE OF REPORT & PERIOD COVERED
Master's Thesis; March 1983

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
James T. Freihofer
Daniel S. Beach

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Naval Postgraduate School
Monterey, California 93940

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
Naval Postgraduate School
Monterey, California 93940

12. REPORT DATE
March 1983

13. NUMBER OF PAGES
91

14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)

15. SECURITY CLASS. (of this report)

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Guaranty, Warranty, Workmanship, Defective material, Contractor liability, Shipbuilding

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
The extension of contractor liability beyond delivery is an essential element in contracting when complex weapons systems are involved. Warranty/Guaranty clauses are currently being included in shipbuilding contracts as a means of incentivizing contractors to provide quality workmanship and materials. The authors have investigated the results of one Warranty/Guaranty effort, the U.S. Navy's Spruance Class Shipbuilding Program, and constructed a

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Block #20 Contd.

Cost-Effectiveness Model to evaluate actual performance on three ships of that Class. Lessons learned are identified and presented which could be incorporated into future Warranty/Guaranty policy decisions.

Approved for public release; distribution unlimited

The Warranty Guaranty Clause: An Analysis of its Use on the Spruance Class (DD-963) Shipbuilding Contract and Identification of Lessons Learned

by

James T. Freihofer
Lieutenant Commander, Supply Corps, United States Navy
B.S., Southeast Missouri University, 1971

and

Daniel S. Beach
Lieutenant, United States Navy
B.S., U.S. Naval Academy, 1977

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
March 1983

Mews
F799
c.1

ABSTRACT

The extension of contractor liability beyond delivery is an essential element in contracting when complex weapons systems are involved. Warranty/Guaranty clauses are currently being included in shipbuilding contracts as a means of incentivizing contractors to provide quality workmanship and materials. The authors have investigated the results of one Warranty/Guaranty effort, the U.S. Navy's Spruance Class Shipbuilding Program, and constructed a Cost-Effectiveness Model to evaluate actual performance on three ships of that Class. Lessons learned are identified and presented which could be incorporated into future Warranty/Guaranty policy decisions.

TABLE OF CONTENTS

I. INTRODUCTION ---------- 9

A. GENERAL ---------- 10

B. RESEARCH QUESTIONS ---------- 10

C. SCOPE, LIMITATIONS, AND ASSUMPTIONS ---------- 11

1. Scope ---------- 11

2. Limitations ---------- 11

3. Assumptions ---------- 11

D. METHODOLOGY ---------- 12

1. Initial Literature Search ---------- 12

2. Archival Research ---------- 13

3. Interviews ---------- 13

4. Detailed Literature Search ---------- 13

II. THE STRUCTURE, CONDUCT AND PERFORMANCE OF THE DD-963 WARRANTY/GUARANTY PROGRAM ---------- 14

A. DD-963 CONTRACT REVIEW ---------- 14

1. Article XII Warranty Period ---------- 15

2. Contract Modifications ---------- 18

B. COMMAND RESPONSIBILITY IN THE WARRANTY/ GUARANTY PROGRAM ---------- 19

1. The Supervisor of Shipbuilding, Conversion and Repair ---------- 19

2. The Prospective Commanding Officer ------ 21

3. Meetings ---------- 24

4. Summary ---------- 26

III. COST EFFECTIVENESS EVALUATION ---------- 28
A. DEFINITION OF THE PROBLEM ---------- 28
B. OBJECTIVES ---------- 28
C. ALTERNATIVES ---------- 29
D. CRITERION ---------- 30
E. METHODOLOGY ---------- 31
F. EFFECTIVENESS AND COST ANALYSIS ---------- 34
1. Assumptions ---------- 34
2. Effectiveness Model ---------- 35
3. Cost Model ---------- 37
G. EVALUATION OF ALTERNATIVES ---------- 38
1. Quantifiables ---------- 38
2. Sensitivity Analysis ---------- 39
3. Non-quantifiables ---------- 45
H. CONCLUSIONS AND RECOMMENDATIONS ---------- 45
1. Conclusions ---------- 45
2. Recommendations ---------- 46
IV. INTERNAL CONTROL ---------- 48
A. OPTAR REPORTING SYSTEM ---------- 49
B. 3M REPORTING SYSTEM ---------- 50
1. Poor Record Keeping ---------- 52
2. Materials Only Work Items ---------- 53
3. Negotiation of Manhours by Shipboard Personnel ---------- 53
C. PRECOMMISSIONING CREW TRAINING ---------- 54
D. RECOMMENDATIONS ---------- 55
E. SUMMARY ---------- 57

V. CONCLUSIONS AND RECOMMENDATIONS ---------- 58

A. CONCLUSIONS ---------- 58

B. RECOMMENDATIONS ---------- 61

APPENDIX A: WARRANTY/GUARANTY CONTRACT ARTICLES --- 64

APPENDIX B: CHAPTER III TABLES ---------- 75

APPENDIX C: NO. W/G ITEMS - USS LEFTWICH ---------- 83

APPENDIX D: NO. W/G ITEMS - USS THORN ---------- 84

APPENDIX E: NO. W/G ITEMS - USS FLETCHER ---------- 85

APPENDIX F: PERCENT DISCOVERED - USS LEFTWICH ----- 86

APPENDIX G: PERCENT DISCOVERED - USS THORN -------- 87

APPENDIX H: PERCENT DISCOVERED - USS FLETCHER ----- 88

LIST OF REFERENCES ---------- 89

INITIAL DISTRIBUTION LIST ---------- 90

LIST OF TABLES

I.	SUMMARY OF SHIPS DATA	36
II.	WARRANTY/GUARANTY WORK EFFORT ACCUMULATION	36
III.	USS LEFTWICH - DD984	39
IV.	USS THORN - DD988	40
V.	USS FLETCHER - DD992	41
VI.	OPTIMUM W/G LENGTH - ACTUAL	42
VII.	REPAIR DOLLARS REMAINING ACTUAL	42
VIII.	NINE MONTH W/G PERIOD (39 WEEKS)	43
IX.	OPTIMUM W/G LENGTH - CLASS AVE MODEL	43
X.	REPAIR DOLLARS REMAINING CLASS AVE MODEL	43
XI.	NINE MONTH W/G PERIOD (39 WEEKS) - CLASS AVE MODEL	44
XII.	MATERIAL EXPENDITURES	50
XIII.	MANHOUR STATISTICS	52

I. INTRODUCTION

The extension of contractor liability beyond delivery is an essential element in contracting when complex weapons systems are involved. Modern weapons platforms are so technically complex that it is virtually impossible to test and accept them in a short period of time. Quality assurance and acceptance testing must be performed under actual conditions, which necessitate warranty periods that extend well beyond the initial delivery date.

Warranty/Guaranty clauses are currently being included in shipbuilding contracts as a means of incentivizing contractors to provide quality workmanship. By putting the contractors on notice that they will be held accountable for defective workmanship and materials, these clauses provide the government's contractual right to assert claims regarding defects discovered after acceptance of the weapons system, and they set forth the rights and obligations of both parties. Warranty clauses are specifically written not to narrow any rights afforded the government under the provisions of the inspections clause relating to latent defects, fraud, and gross mistakes.

> "These rights include correction of deficiencies or defects, reperformance, and equitable adjustment in the contract price or other remedies as required." [Ref. 1]

Various contract types and warranty coverage periods have been used in the past. Extensive literature searches indicate no prior effort has been made to review a completed warranty program of this type in order to identify lessons that might have been learned, evaluate those lessons, or make recommendations which could be incorporated into future warranty/guaranty policy. This thesis will attempt to identify, based on three case studies of DD-963 class ships, lessons learned and their implications on future policy development.

A. GENERAL

The major focus of this thesis is to review the Spruance class destroyer (DD-963) warranty/guaranty program. The methodology is in-depth case study on three ships of the class. The goal is to review the actual performance of the contract warranty/guaranty provisions in order to arrive at lessons learned. These lessons could become the basis for future planning of shipbuilding warranty/guaranty coverage.

B. RESEARCH QUESTIONS

1. Was there an underlying pattern for deficient work identification throughout the Spruance class destroyer acquisition program?

2. Was the one-year warranty clause utilized in this contract cost-effective?

3. What was the optimal length of time for the warranty period in this shipbuilding program based on the historical data reviewed?

4. How effective was the Navy's maintenance and material management (3M) system in recording warranty/guaranty work items and ship's force man hours expended in support of the warranty/guaranty coverage?

5. Should the lessons learned on this particular shipbuilding contract clause be incorporated in future shipbuilding contracts to reduce contract costs?

C. SCOPE, LIMITATIONS, AND ASSUMPTIONS

1. Scope

This research is limited to the Spruance class (DD-963) shipbuilding program. Other shipbuilding programs will not be discussed or compared. Three Spruance class ships, USS Leftwich (DD-984), USS Thorn (DD-988) and USS Fletcher (DD-992), will be investigated within the framework of the research questions posed.

2. Limitations

Operational scheduling considerations of new construction ships are complex. The possible scheduling problems created by the shortening of the warranty period were not researched.

3. Assumptions

It is assumed that the reader of this thesis has a basic knowledge of the U.S. shipbuilding industry, U.S. Navy

weapons systems acquisition process and U.S. Government procurement policy.

It has also been assumed that the length of a warranty period directly affects the amount of risk a contractor is exposed to in warranty programs. Increased risk translates to increased cost for the government.

D. METHODOLOGY

The research was conducted in three phases. An initial literature search was conducted to gain a basic understanding of the warranty concept and the Spruance class shipbuilding effort. This was followed by extensive archival research of cost data, work deficiency reports and ships' histories. Statistical techniques were used to reduce the data and provide insight into trends that occurred. A cost-effectiveness model was constructed to analyze the actual performance of the warranty/guaranty program on three ships of the class. Finally, a more detailed literature review was pursued and several interviews were conducted with representatives from the Naval Sea Systems Command, the Supervisor of Shipbuilding, Conversion and Repair (SUPSHIP), Pascagoula, Mississippi, and Ingalls Shipbuilding, Litton Industries to develop the issues.

1. Initial Literature Search

The primary source of literature in this search was the Defense Logistics Study Information Exchange (DLSIE).

This provided background articles and presentations on current warranty issues within the Department of Defense.

2. Archival Research

The records of the Supervisor of Shipbuilding, Conversion and Repair, Pascagoula, Mississippi and Ingalls Shipbuilding Division of Litton Industries provided background information and cost data on the program.

3. Interviews

Two approaches were used in interviews: telephone interviews were used for people in the Naval Sea Systems Command and personal interviews were conducted with representatives from both Ingalls and SUPSHIP Pascagoula.

4. Detailed Literature Search

A computer search of the ABI/INFORM database was conducted by the Dudley Knox Library at the Naval Postgraduate School using the descriptors warranty, guaranty, and contracts. There were many recent articles and studies on reliability improvement type warranties and related issues but it was found that little information existed on warranties relating to the correction of deficient workmanship and material.

II. THE STRUCTURE, CONDUCT AND PERFORMANCE OF THE DD-963 WARRANTY GUARANTY/PROGRAM

The purpose of this chapter is to provide a brief overview of the DD-963 contract, to identify the applicable contract articles which governed the program, and to describe the manner in which the program was conducted. Article XII WARRANTY PERIOD and the standard operating procedures for implementation and execution of the warranty form the basic framework for this discussion. Analysis of the financial and maintenance data will be examined in a subsequent chapter.

A. DD-963 CONTRACT REVIEW

The DD-963 contract is the largest single shipbuilding contract ever awarded by the U.S. Navy, a total of 30 destroyers. It represents a new contracting approach wherein design, engineering, construction and fleet readiness were all provided by a single contractor under a fixed-price incentive contract. Both Litton Industries and the U.S. Navy at the time of contract award in 1970 realized it would be difficult to accurately estimate all costs that would be incurred during the eight years of ship design, engineering and production. As a result, an agreement was made on cost parameters which provided for negotiation to determine the final price for the ships midway through the contract, when more accurate estimates could be obtained. This negotiation

process went through several iterations which began in October 1973 and ended 30 July 1978. Contract modification P00064 implemented a settlement agreed on by both parties based upon an estimated total allowable cost. The Secretary of Defense determined that the agreement would facilitate national defense and could be processed under the authority of Public Law 85-804. The entire controversy surrounding the claim, court proceedings and final resolution is not considered to have had a significant effect on the execution of the Warranty/Guaranty program other than serving to indemnify the contractor from claims based on design and engineering faults as covered in Article XI of the contract. Article XI is contained in Appendix A herein; however, the effects of the article are not considered by this study. The boilerplate articles, XXII Contractor Personnel (Warranty Engineers) and XXIII Capture and Detention, are also contained in Appendix A for the convenience and reference of the reader. These articles are self explanatory in nature and do not enter into the analysis that follows. As of this writing, approximately three years after the delivery of the last ship, the DD-963 contract closeout is still being negotiated.

1. Article XII Warranty Period

The following contract article provided the majority of Warranty guidance in the DD-963 program.

ARTICLE XII. WARRANTY PERIOD

(a) The Contractor warrants that for a period of twelve (12) months of unrestricted service after delivery of each vessel constructed and delivered under this contract, each vessel shall be free from defects in material and workmanship. Upon delivery of each vessel, the Contracting Officer shall give the Contractor written notice of the proposed expiration date of this warranty. The Warranty Period shall be extended for any period in which a vessel is unavailable for unrestricted service due to defects in material or workmanship, or correction of design and engineering deficiencies under Article XI of this contract. When such defect is corrected and the vessel is again available for unrestricted service, the Contracting Officer shall give the Contractor written notice of the revised expiration date of this warranty.

(b) The Contractor may, at its own expense, maintain on board each vessel, a warranty engineer who shall be afforded every reasonable opportunity to inspect such vessel in all its parts except for such areas as may be restricted because of military security. Such warranty engineer shall have no power to direct or control the operation of said vessel or vessels. In the event a warranty engineer decides that maintenance procedures are not being accomplished or that operating procedures are not being accomplished or that operating procedures in use will in any way void any part of this warranty, he shall immediately notify the Commanding Officer of the ship, the Supervisor, the Contracting Officer, and the Project Manager, DX/DXG Project, Washington, D.C.

(c) The Contractor shall at its own expense correct any and all defects which constitute a breach or breaches of this warranty. The Government shall notify the Contractor in writing within thirty (30) days of discovery of any conditions which are deemed to be covered by this warranty. The Government shall have the option of correcting the condition aboard the vessel at its location, having the condition corrected at the nearest repair yard to the vessel's location, or, whenever the condition will not interfere with the continued operation of the vessel, having the vessel returned to the Contractor's shipyard for correction of the condition. In the event such condition requires immediate correction in order to continue the safe operation of the vessel, the Government shall notify the Contractor in writing within five (5) days after the discovery of the condition and before repair, if practicable. When due to emergency conditions or due to election by the Government corrective action is taken at a location other than the Contractor's yard, an invoice shall be furnished to the

Contractor for services rendered and shall be duly certified by the Government that:

(i) all such services were required to accomplish corrections which are deemed to be the responsibility of the Contractor under this Article;

(ii) all such services were required under emergency conditions or were required to be performed under circumstances where Contractor personnel were not reasonable available;

(iii) a copy of all data available to the Government concerning such repairs has been made available to the Contractor or will be made available upon request;

(iv) payment has been made by the Government for such services. Promptly upon receipt of any such invoice, the Contractor shall either pay the amount due, subject, however, to the "Disputes" clause of this contract or shall negotiate the amount due with the Contracting Officer.

(d) The liability of the Contractor under this warranty is limited to the correction of defects in material or workmanship in the vessels, and consequential or special damages are expressly excluded. The provisions of this Article shall not be applicable to:

(i) Government-furnished equipment, materials, and supplies, except the installation thereof;

(ii) accidents, misuse, abuse, improper operational procedures, or negligence by non-Contractor personnel;

(iii) repairs, corrections, replacements, alterations, or additions by source other than the Contractor, except under emergency conditions as herein provided.

(iv) damage caused by perils of the sea, rivers, or navigation or by exposure to unreasonable environmental conditions.

(v) replacement of DD-963 components in accordance with the Maintenance Plan;

(vi) deficiencies caused by failure of the Government to perform maintenance in accordance with the Plans of Maintenance.

(e) Failure to agree upon any determination to be made under this clause shall be a dispute concerning a question of fact within the meaning of the "Disputes" clause of this contract.

(f) The rights and remedies of the Government provided in this clause are in addition to and do not limit any rights afforded to the Government under any other clause of this contract.

(g) Prior to establishment of the combined total final price under Article XXI hereof "Incentive Price Revision (Firm Target)" and prior to establishment of the total compensation to be paid under paragraph (f) of Article IV, "Compensation Under Contracts N00024-69-c-0283 and N00024-70-C-0275", all costs incurred, or to be incurred, by the Contractor, in complying with this Article shall be considered when negotiating the combined total final price

and the total compensation under Article IV and XXI. After establishment of the combined total final price and the total compensation to be paid, Contractor compliance with this Article shall be at the Contractor's expense and at no increase in the total final price and total compensation to be paid. [Ref. 2]

2. Contract Modifications

In the course of the contract, two contract modifications affected the Warranty/Guaranty articles of the contract. Article XI was modified by P00042 on 23 July 1975. This modification imposed a $900,000.00 ceiling on the cost that the contractor could claim in providing warranty engineers and support for administration of contractor obligations under the contract provisions. Article XI was subsequently deleted in its entirety by P00064, as part of the agreement made between the Government and the contractor under the authority of Public Law 85-804 in settlement of the dispute as discussed earlier. This government concession ceded to Ingalls' contention that contractor liability for design and engineering ended upon acceptance of Ingalls' engineering plans and drawings by NAVSEA, prior to entering the production phase of the program. For the most part, these two modifications were the only ones that affected warranty coverage. Several modifications changed items from contractor provided material to government furnished which, in effect, changed contractor liability in regard to the item; however, decisions of this nature are made by the program office and the effect on the warranty coverage is considered when the decision is made.

B. COMMAND RESPONSIBILITY IN THE WARRANTY/GUARANTY PROGRAM

Two Navy organizations worked together in the acceptance of new construction ships for the U.S. Government: the Naval Sea Systems Command, represented by the onsite Supervisor of Shipbuilding, Conversion, and Repair (SUPSHIP), and the type commander (TYCOM), represented by the Prospective Commanding Officer (PCO). The Fleet Introduction Team (FIT) is responsible for functions of the Prospective Commanding Officer until he is actually onsite and able to conduct his own business. As the warranty period began at delivery with the PCO well ensconced, FIT was not involved in the conduct of the Warranty/Guaranty program.

1. The Supervisor of Shipbuilding, Conversion and Repair

SUPSHIP Pascagoula served as the Administrative Contracting Officer for the DD-963 contract. To aid in management and control of the Warranty/Guaranty program SUPSHIP Instruction 4330.8A was promulgated providing policy guidance in Warranty/Guaranty issues. The instruction designated the Contracting Officer, Code 400, as the primary office within the SUPSHIP organization responsible for Warranty/Guaranty coordination. Code 400 was tasked with the following duties with regard to the Warranty/Guaranty program.

(a) Upon ship delivery, advise the contractor, the Prospective Commanding Officer of the ship, and other interested parties of the specific start and

contractual completion date of the guarantee (or warranty) period and, should the ship be determined by competent authority to be removed from unrestricted service during the period, the revised expiration date.

(b) Provide a Warranty/Guaranty information package to the ship's Prospective Commanding Officer and department heads and make an oral presentation on Warranty/Guaranty requirements to the ship's force (department heads) prior to delivery of each ship.

(c) Maintain a file and the status of work items submitted under the program by the ship and coordinate the resolution of all rejected or disputed work items.

(d) Coordinate all SUPSHIP action required to ensure the contractor fulfills his responsibilities under the Warranty/Guaranty provisions.

(e) Follow all high priority work items to ensure the contractor is taking appropriate action.

(f) Maintain a file of all open casualty reports submitted during the Warranty/Guaranty period of each ship.

(g) Coordinate with SUPSHIP Code 151, 154, 200, 300, and 500 for identification of, correspondence concerning, and successful resolution of all DD Class performance, maintainability, and reliability defects.

(h) Plan necessary responses to disputed Warranty/Guaranty defects including the drafting of legally sufficient contractual language to insure that government rights are preserved.

(i) Control all design deficiency activity including issuing administrative control numbers, tracking for timely responses, advising NAVSEA counterparts, and providing monthly status reports of latest activity.

(j) For those contractor responsible workmanship or material deficiencies corrected by ship's force or other activity at the option of the Navy, request from the party correcting the deficiency a statement of manhours and/or material dollars expended.

(k) Forward to the manager of the proposal evaluation division those deficiencies for which no manhour and

material estimates have been provided or for which the estimate involved merits additional review, for the development of Technical Analysis Reports (TAR).

(l) Execute modifications and/or invoice the contractor for recovery of funds expended by the government for correction of contractor responsible deficiencies.

(m) Monitor orders placed in support of warranty/guaranty work items so that a mutually agreeable credit can be obtained from the contractor if it is subsequently determined that an item is a replacement under the Warranty/Guaranty provisions of the contract. [Ref. 3]

2. The Prospective Commanding Officer

The Commanding Officer (CO) of each new construction ship was responsible for the identification and reporting of Warranty/Guaranty discrepancies. Ship's force personnel served as inspectors who ultimately accepted or rejected work items submitted. The CO would designate a Warranty/Guaranty Officer who would coordinate shipboard efforts, provide continuity and act as point of contact onboard the ship for the Warranty Engineer. The reporting and management system utilized the existing Navy Maintenance and Material Management (3M) system, supply system, and Casualty Report (CASREP) system. Use of existing systems reduced redundant reporting requirements and ensured additional reporting requirements would be held to a minimum. Additionally, by utilization of fleet systems it was hoped that the system would be readily understood by the fleet personnel who actually would do the reporting.

a. Documentation

The vehicle used by ship's force personnel to communicate Warranty/Guaranty deficiencies was the standard OPNAV 4790.2K, Ships Maintenance Action Form (2K) which was prepared and submitted at the workcenter level. The entries required on the 2K were essentially the same as required for any other maintenance action with the following exceptions:

(1) The first line of the remarks block (Number 35) must be annotated as follows: "Warranty Item 992-xxx" (Hull Number-Serial number)

(2) Block 46 must contain the letters "WG".

b. Distribution of Documentation

Distribution of the 4790.2K was expanded to include the activities concerned with the Warranty/Guaranty program. Warranty/Guaranty 2K's were distributed as follows:

(1) Two copies to the Ingalls Warranty Engineer.

(2) One copy retained for the shipboard coordinator's file.

(3) Two copies were submitted to the ship's 3m coordinator for submission to the Navy's Maintenance System.

(4) One copy was forwarded to SUPSHIP Pascagoula, Code 451.

(5) One copy was forwarded to NAVSEA PMS-389.

c. Work Items Requiring CASREP Reporting

If a warranty item denigrated the ship's capability to the point where the problem was designated a casualty by the CO, a casualty report was forwarded via the normal CASREP reporting system. The CASREP message included

the Warranty/Guaranty serial number along with a statement regarding the adequacy of the action being taken by the contractor to correct the problem. CASREP reporting brought high level review of any problems incurred and speeded communication among the program managers and the operating units.

d. Acquisition of Repair Parts

Repair parts required in the correction of Warranty/Guaranty deficiencies were acquired on the following bases:

A. Normal acquisition of required warranty items was made using the following procedures:

1. COSAL and/or parts with FSN/NSN part numbers were acquired from Navy Supply System.

2. Other than COSAL and/or FSN/NSN parts or if not available under 1 above were to be acquired by Ingalls from vendors if possible upon notification of warranty engineer assigned to the vessel.

3. If any part was not available from 1 and 2 the Contractor would take from production assets on a "not to interfere with schedule" basis.

4. If not available under 1, 2, or 3, Ingalls was to notify SUPSHIP that taking from production assets could impact on delivery of production ships and ask for guidance.

B. Abnormal acquisition of parts required to prevent impacting operational schedules of the ships were acquired on the following basis:

1. Part was acquired by A1, A2, or A3 whichever was most expedient.

2. If the required part was not available under B1, A4 applied. [Ref. 3]

e. Reimbursable OPTAR

Repair parts consumed in support of the Warranty/Guaranty Program requisitioned from the Navy System or paid for utilizing Navy funds were charged against a special budget operating target (OPTAR) which was provided each ship by the cognizant Type Commander specifically for procurement of warranty items. These OPTARs were maintained and reports were prepared in accordance with Naval Supply Systems Command Publication 3013. The Type Commander was reimbursed by NAVSEA for any expenditures in support of the Warranty/Guaranty Program. NAVSEA in turn was reimbursed by the contractor for items or work paid for by the Navy in support of the Warranty/Guaranty Program.

f. Reimbursement for Ship's Force Manhours Expended

The contractor reimbursed the Government for documented Ship's Force manhours expended on Warranty/Guaranty items. The hours expended were documented via the 2K and managed on a quarterly basis in the review made by the Ingalls Warranty Engineer. The amount due the Government was established as the E-5 rate published and updated by the Navy Comptroller (NAVCOMP) in NAVCOMP NOTICE 7041.

3. Meetings

Once commissioned, Navy ships become part of a mobile force which by nature does not remain in one place and is usually involved in maintaining a hectic schedule. To facilitate incremental agreement and proper communication between

the ship, the contractor and the SUPSHIP organization, several meetings were normally scheduled throughout the Warranty period. The meetings were scheduled on a quarterly basis between the Ingalls Warranty Engineer and the shipboard coordinator. A final closeout conference was held that included a representative from SUPSHIP Code 400.

a. Quarterly Review

The quarterly review was generally a low key working meeting between the Warranty Engineer and the shipboard coordinator. The agenda included ascertaining the status of all work items, the status of the Warranty/Guaranty OPTAR and the amount of ship's force manhours expended by the ship. Agreement on these areas was generally obtained and problem areas or items were discussed.

b. Warranty/Guaranty Closeout

Immediately prior to the expiration of the Warranty/Guaranty period a final closeout conference was scheduled. Representatives from Ingalls, SUPSHIP and ship's force were in attendance. The purpose of the meeting was to gain agreement and document three areas of concern: disputed items, items that would remain open beyond the warranty window, and the amount expended in ship's force manhours and from the reimbursable OPTAR for material. At the close of the meeting the Commanding Officer forwarded a letter to SUPSHIP documenting the results of the meeting which provided a major input to the ACO's negotiating position with regard

to the amount of money due the government for reimbursement of manhours and material expended in support of the program by ship's force.

4. Summary

The DD-963 contract represents one of the largest defense contracts ever entered into by the U.S. Government. The scope and format of the contract make the DD-963 project truly unique among shipbuilding programs.

The Warranty/Guaranty articles in the contract were designed to extend the contractor's responsibility for workmanship, performance, design and reliability beyond final acceptance of the vessels. As in any complex weapon system acquisition there were a number of contract modifications; however, for the most part the modifications had little effect on the actual application of the warranty to the program or in the day-to-day administration of the warranty provisions of the contract.

The coordination between the Navy commands involved in the administration of the program was well defined and utilized the existing Navy 3M, Supply and CASREP reporting systems to document and communicate problems that were identified. This maintained the extra reporting workload at a minimum for the commissioning crew who were initially inundated by the management problems involved in the commissioning of a new ship.

Meetings were conducted on a timely interval which allowed problems to be resolved and agreement to be gained on an incremental basis without ever burdening the commissioning crew whose time was already at a premium.

III. COST EFFECTIVENESS EVALUATION

A. DEFINITION OF THE PROBLEM

To date, and continuing into the foreseeable future, there exists no definitive set of inspection procedures which absolutely guarantees the U.S. Government acceptance of complex weapons systems with no defects in material and workmanship. In the case of a Navy warship, this problem leads to the question of whether to extend contractor liability beyond delivery and acceptance for costs of correcting discovered patent defects. This problem faces the Program Manager and Procurement Contracting Officer (PCO) as they prepare to negotiate terms and conditions of any major ship acquisition. They must answer the following questions:

(1) Do we want a Warranty/Guaranty clause in the contract?

(2) If so, what type of contract clause should be used?

(3) How long should the period of coverage be?

(4) How much money should be allocated for this purpose?

(5) What effect would this type of coverage have on the contractor?

B. OBJECTIVES

The primary objectives of the Program Manager are to get the new ship delivered at or under contract cost targets, on or before required delivery date, with the minimum possible defects still in existence after acceptance by the Government.

He is constrained by the resources obligated to him, and must choose an effective method of achieving these goals within the cost limitations imposed. The objective of this analysis is to determine the most cost effective way of correcting defects in material and workmanship which are not discovered in the inspection process. An assumption is made that no additional efficiency in inspection procedures can be achieved in the short term, and that some defective material and workmanship items will exist at time of delivery due to the complexity of the shipbuilding process.

C. ALTERNATIVES

Three alternative methods of achieving the objective were considered:

1. Do not have a Warranty/Guaranty coverage period. Description: This alternative requires that the correction of defective material and workmanship be done by the ship's company using their own labor and materials, or by acquiring assistance from navy repair facilities or external contractors.

2. Include a Cost Reimbursement Warranty/Guaranty clause. Description: This alternative provides correction of the defective material and workmanship by the prime contractor, but all costs of corrective action are added to the total cost of the contract.

3. Provide Warranty/Guaranty coverage for a specific period of time after acceptance of the ship, but add the

cost of this coverage to the total cost of the ship. A maximum/minimum profit figure is negotiated based on actual ship cost in relation to target cost. A maximum total amount available for warranty work is established, and as each ship's warranty costs are totalled, the total cost is credited to the Warranty/Guaranty account, and the balance is the amount available for the remainder of the ships.

Description: This method provides an incentive to the contractor to perform efficiently and effectively, while limiting the total liability of both the Government and the Contractor to a pre-established amount. The lower the total cost of each ship, the higher the contractor's profit up to the maximum profit allowed. The contractor is guaranteed a minimum profit per ship.

D. CRITERION

The Government criterion for choosing between these alternatives should be fixed effectiveness, minimum marginal cost. The objective is to correct as much defective material and workmanship existing at the time of delivery, up to the point where the marginal benefits obtained from correction at least equal the marginal costs for the Warranty/Guaranty clause being extended an additional increment of time. Once the desired effectiveness level is set, the length of time for which the marginal benefits at least equal the marginal costs should be selected, all other things considered equal.

The assumption made here is that benefits can be quantified in terms of dollars. Non-quantifiable benefits cannot be ignored and will be addressed in all cases.

E. METHODOLOGY

The alternatives described as no Warranty/Guaranty coverage and cost reimbursement warranty coverage will not be analyzed in depth. The U.S. Navy, in building the Spruance class destroyer, recognized the problems which would be associated with either of these alternatives. If no Warranty/Guaranty coverage was afforded, the total repair effort would be that of ship's company or Navy repair yards. This was absolutely unacceptable because of operating requirements for the new ships, and limitations on the availability of repair facilities capable of this kind of repair effort. Further, this approach does not motivate the contractor to deliver a quality product, nor does it take advantage of his expertise gained in production. Current repair efforts in the active fleet plus the scheduled requirements of putting the new ships through their initial shakedowns and adding new weapon systems not already installed during construction do not permit the total repair effort to be accomplished by the Navy. Equally unacceptable would be the cost reimbursement method. Assuming that the inspection procedures remain constant in their effectiveness, a contractor would be disincentivized to provide quality workmanship and materials. Any defects

in these areas would be reimbursed dollar for dollar by the Government. Overhead would effectively be spread over a larger dollar base, and the contractor could actually "get well" by performing lower quality work.

The third alternative listed was, in fact, the method selected by the U.S. Navy on the Spruance class shipbuilding contract. This analysis supports their decision to select this type of contract vehicle given the objectives to be achieved. The evaluation will attempt to apply the criterion discussed earlier to the performance of this type of Warranty/Guaranty clause.

The method of this analysis is to explore, using three ships of the Spruance Class, the results of this particular effort by the U.S. Navy to solve the stated problem. Historical cost records and actual ships' schedules and maintenance actions were compiled and evaluated. One frailty which accrues to this method is obvious: archival records are only as good as the original measurement and record keeping effort. The cost data represents Ingalls' actual cost as recorded and accrued for each ship's material and workmanship accepted as deficient under the Warranty/Guaranty clause of the contract. No additional profit was added to this cost objective. The ship's schedules were distilled from Ships' Histories filed with the Navy Type Commander to which that ship was responsible for the periods concerned. Maintenance records were retrieved from Warranty/Guaranty books compiled by the Ingalls' Warranty/Guaranty Engineer.

One other important aspect of the methodology must be explained. Although the three ships were not selected at random, as statistically defined, they were also not contrived to achieve a particular point. The three ships were chosen for the completeness of the data available. They also represent ships which have achieved relatively equal efficiency in regard to information available to aid them in their management tasks.

Raw data on the total cost and number of maintenance actions for all ships were compiled (Appendix B). This data was summarized and compared for each of the selected ships (Table I). Each selected ship's raw data was summarized according to the occurrence of Warranty/Guaranty items during its coverage period (Appendix B) and displayed graphically (Appendixes C, D, and E). Also compiled was the cumulative work effort as it proceeded through the warranty period (Appendix B) and this is presented graphically (Appendixes F, G, and H). A table of data summarizing each selected ship's work effort accumulation is included (Table II).

In order to tie together the incurrence of warranty items with the activities of each ship, a time line of key events was added below the graph of weekly item frequency (Appendixes C, D, and E). This presentation of data allows the analyst to view the results of a prior Warranty/Guaranty effort and to evaluate the actual total costs per ship. The patterns by which defective material and workmanship accrue

can then be identified, particularly in relation to key scheduled events during the warranty period. An assessment of the length of time chosen for the warranty period in relation to work accumulation and marginal benefits to the Government can then be made.

From this framework, the objective of this analysis was to evaluate cost and effectiveness of an existing Warranty/Guaranty clause and identify lessons learned for future shipbuilding planning efforts.

F. EFFECTIVENESS AND COST ANALYSIS

1. Assumptions

In order to evaluate the cost effectiveness of this particular Warranty/Guaranty clause, data on the total cost per ship, number and timing of defective workmanship and material reports, and individual ship's schedules during the Warranty/Guaranty period were compiled as described earlier. The actual cost per work item was not retrievable from the data collection system. This forced the usage of an average cost per work item established by dividing the total cost per ship by the number of work items per ship. Although the analysis would be more precise using exact cost data, it is felt that the nature of defective workmanship and material discovery would have no correlation to the actual cost of that defective work. Therefore, the higher and lower costs would be randomly distributed throughout the Warranty/Guaranty

period, and the use of an average cost per work item is a reasonable surrogate to the more precise actual costs.

Using the same rationale, a class average cost per work item was established using the summary data for all thirty ships of the class. The accuracy limitations of this estimator are recognized; however, no attempt was made in further refining the average cost in relation to the learning curve that was occurring throughout the production period. Each ship's total cost and number of work items had no identifiable decreasing pattern that would indicate a predictable learning curve rate when applied to the Warranty/Guaranty area. Again, based on the limitations of data available, and a brief analysis of the patterns reflected by that information, average cost per work item for the whole Spruance Class shipbuilding effort was used in the measurement of cost effectiveness.

2. Effectiveness Model

Table I shows the average expense per 2K for each of the sample ships. By plotting the frequency of work items discovered for the fifty-two week Warranty/Guaranty period for each ship (Appendixes C, D, and E), and also analyzing the cumulative total of work items discovered throughout the period (Appendixes F, G, and H), it became clear that the effectiveness model needed to measure how long the Warranty/Guaranty period should have been, given various desired effectiveness levels. Table II connects the work

TABLE I

SUMMARY OF SHIPS DATA

SHIP	NO. OF 2K	TOT. W/G COST	AVE.EXP./2K
USS LEFTWICH	299	$160489.76	$536.76
USS THORN	429	105637.27	246.24
USS FLETCHER	328	77640.58	236.71
SAMPLE MEAN	352	114589.20	
ADDITIONAL SUMMARY OF ALL SHIPS IN THE CLASS			
TOTAL	12283	$8119346.61	$661.02
MEAN	409.43	270644.89	
STD. DEVIATION	173.16	262481.78	
COEF. OF DEV.	0.42	0.97	

TABLE II

WARRANTY/GUARANTY WORK EFFORT ACCUMULATION

	PERCENT COMPLETED			
	25%	50%	75%	100%
USS LEFTWICH	5	15	27	52
USS THORN	4	16	24	48
USS FLETCHER	2	7	24	46
MEAN	3.67	12.67	25	48.67
STD. DEVIATION	1.53	4.93	1.73	3.06
COEF. OF DEVIATION	0.42	0.39	0.07	0.07

NUMBERS ARE IN WEEKS AFTER DELIVERY
OF SHIPS TO THE GOVERNMENT

item accumulation and the length of time by summarizing various effectiveness levels that were achieved throughout the warranty period. Effectiveness level is defined as the number of 2K's discovered by a certain time period divided by the total number of 2K's discovered over the entire twelve month warranty period.

3. Cost Model

As discussed earlier, the cost model used average costs. For each ship, it was assumed that the marginal benefit accruing to that ship for any given period of time was the number of work items discovered multiplied by the average cost per work item for that ship, as identified in Table I. The marginal cost of each additional period of coverage was assumed to be the class average cost per ship divided by the fifty-two weeks of coverage. As shown in Table I, this class average cost was $270,644.89. The average cost per week was assumed to accumulate linearly over the fifty-two weeks, with each week of coverage costing $270,644.89/52 weeks = $5,205 per week.

By applying this analysis, a table consisting of Effectiveness level (as defined in Table II), Week number, Actual Benefit, Benefits Foregone (those yet to be discovered), Net Benefit, and Marginal Benefit could be constructed. Net Benefit is defined at any particular point during the warranty period as the benefits actually accrued less those remaining to be discovered. The marginal benefit is, from

week to week, the additional value of work discovered by continuing for that additional week. The final analysis must determine for any desired minimum effectiveness level, what length of time would have been optimal. This was established by determining at what week, after a given effectiveness level was achieved, the marginal benefits drop below the additional marginal cost of extending coverage for that extra week. This process forms the basis for the evaluation of alternatives.

G. EVALUATION OF ALTERNATIVES

1. Quantifiables

Tables III, IV, and V summarize the data collected using the cost effectiveness model described above.

Table VI summarizes the optimum number of weeks required to achieve effectiveness levels ranging from 75 percent to 95 percent in increments of 5 percent.

Table VII shows the amount of dollars of repair per ship remaining for which the Navy would be responsible if it were to choose various effectiveness levels.

Table VIII displays the actual costs for a 9-month Warranty/Guaranty period arrived at by applying incremental analysis to the data from Table III. Also, budgeted costs using the class average cost per ship, variances between these two figures, and an analysis of whether the variance was favorable or unfavorable is provided. In this case, a

TABLE III

USS LEFTWICH - DD984

%COMP	WEEK NO	ACT. BENE	BENE LOST	NET BENE	MAR. BENE.
68.79	24	110085	49941	60144	****
70.81	25	113307	46719	66588	6444
73.49	26	117603	42423	75180	8592
76.85	27	122973	37053	85920	10740
78.52	28	125658	34368	91290	5370
79.53	29	127269	32757	94512	3222
80.20	30	128343	31683	96660	2148
81.21	31	129954	30072	99882	3222
82.21	32	131565	28461	103104	3222
84.23	33	134787	25239	109548	6444
85.91	34	137472	22554	114918	5370
87.92	35	140694	19332	121362	6444
89.60	36	143379	16647	126732	5370
89.93	37	143916	16110	127806	1074
90.94	38	145527	14499	131028	3222
93.29	39	149286	10740	138546	7518
93.62	40	149823	10203	139620	1074
93.96	41	150360	9666	140694	1074
93.96	42	150360	9666	140694	0
94.30	43	150897	9129	141768	1074
94.30	44	150897	9129	141768	0
96.31	45	154119	5907	148212	6444
96.98	46	155193	4907	150286	2074
96.98	47	155193	4907	150286	0
96.98	48	155193	4907	150286	0
98.32	49	157341	2685	154656	4370
98.66	50	157878	2148	155730	1074
99.33	51	158952	1074	157878	2148
100	52	160026	0	160026	2148

favorable variance means that the actual ship's cost was below the cost budgeted based on the Class Average Ship Model discussed earlier.

2. Sensitivity Analysis

In considering sensitivity, this model must be analyzed for the areas in which it is based on assumption. Since the data on 2K's for each week were actual data they

TABLE IV

USS THORN - DD988

%COMP	WEEK NO	ACT. BENE	BENE LOST	NET BENE	MAR. BENE.
75.25	24	74784	24600	50184	****
77.48	25	76998	22386	54612	4428
81.93	26	81426	17958	63468	8856
85.15	27	84624	14760	69864	6396
89.60	28	89052	10332	78720	8856
90.35	29	89790	9594	80196	1476
91.34	30	90744	8610	82164	1968
91.83	31	91266	8118	83148	984
92.33	32	91758	7626	84132	984
92.57	33	92004	7380	84624	492
92.57	34	92004	7380	84624	0
93.07	35	92496	6888	85608	984
93.07	36	92496	6888	85608	0
93.32	37	92742	6642	86100	492
93.32	38	92742	6642	86100	0
93.56	39	92988	6396	86592	492
93.81	40	93234	6150	87084	492
93.81	41	93234	6150	87084	0
93.81	42	93234	6150	87084	0
94.06	43	93480	5904	87576	492
94.55	44	93972	5412	88560	984
95.54	45	94956	4428	90528	1968
96.29	46	95694	3690	92004	1476
97.52	47	96924	2460	94464	2460
100	48	99384	0	99384	4920
100	49	99384	0	99384	0
100	50	99384	0	99384	0
100	51	99384	0	99384	0
100	52	99384	0	99384	0

would not change. The actual benefits and benefits foregone are subject to change based on the previous decision to use an average cost for each 2K. In order to test the sensitivity of the model to this assumption, the data for actual benefit and benefit foregone was changed to reflect a class average cost per 2K. By making this change, the model would be tested with figures derived from all thirty ships in the class.

TABLE V

USS FLETCHER - DD992

%COMP	WEEK NO	ACT. BENE	BENE LOST	NET BENE	MAR. BENE.
76.69	24	59250	18012	41238	****
77.08	25	59487	17775	41712	474
78.22	26	60435	16827	43608	1896
79.14	27	61146	16116	45030	1422
79.14	28	61146	16116	45030	0
80.06	29	61857	15405	46452	1422
80.98	30	62568	14694	47874	1422
84.05	31	64938	12324	52614	4740
84.36	32	65175	12087	53088	474
87.73	33	67782	9480	58302	5214
91.10	34	70389	6873	63516	5214
92.94	35	71811	5451	66360	2844
93.25	36	72048	5214	66834	474
94.48	37	72996	4266	68730	1896
94.79	38	73233	4029	69204	474
95.40	39	73707	3555	70152	948
96.01	40	74181	3081	71100	948
96.93	41	74892	2370	72522	1422
97.85	42	75603	1659	73944	1422
98.16	43	75840	1422	74418	474
99.69	44	77025	237	76788	2370
99.69	45	77025	237	76788	0
100	46	77262	0	77262	474
100	47	77262	0	77262	0
100	48	77262	0	77262	0
100	49	77262	0	77262	0
100	50	77262	0	77262	0
100	51	77262	0	77262	0
100	52	77262	0	77262	0

Again the authors were restricted in using average costs, but more precise data did not exist.

Tables IX, X, and XI summarize the model's output using this class average cost per 2K in the same format as Tables VI, VII, and VIII. In summary, this model appears to be relatively insensitive to changes in average cost per 2K.

TABLE VI

OPTIMUM W/G LENGTH - ACTUAL

	EFFECTIVENESS LEVEL				
	75%	80%	85%	90%	95%
USS LEFTWICH	29	30	37	38	46
USS THORN	24	29	29	29	45
USS FLETCHER	24	29	35	35	39
MEAN	25.67	29.33	33.67	34	43.33
STD. DEVIATION	2.89	0.58	4.16	4.58	3.79
COEF. OF DEV.	0.11	0.02	0.12	0.13	0.09

FIGURES IN WEEKS AFTER COMMISSIONING

•

TABLE VII

REPAIR DOLLARS REMAINING ACTUAL

	EFFECTIVENESS LEVEL				
	75%	80%	85%	90%	95%
USS LEFTWICH	32757	31683	16110	14499	4907
USS THORN	24600	9594	9594	9594	4428
USS FLETCHER	18012	15405	5451	5451	3555
MEAN	25123	18894	10385	9848	4297
STD. DEVIATION	7386	11450	5373	4529	686
COEF. OF DEV.	0.29	0.61	0.52	0.46	0.16

FIGURES IN $ OF REPAIR REMAINING

TABLE VIII

NINE MONTH W/G PERIOD(39 WEEKS)

SHIP	ACT COST	BUDGET COST	VARIANCE	ANALYSIS
USS LEFTWICH	$149286	$203000	$53714	FAVORABLE
USS THORN	92988	203000	110012	FAVORABLE
USS FLETCHER	73707	203000	129293	FAVORABLE

TABLE IX

OPTIMUM W/G LENGTH - CLASS AVE MODEL

	EFFECTIVENESS LEVEL				
	75%	80%	85%	90%	95%
USS LEFTWICH	29	30	37	38	46
USS THORN	29	29	29	29	46
USS FLETCHER	24	29	36	36	39
MEAN	27.33	29.33	34.00	34.33	43.67
STD. DEVIATION	2.89	0.58	4.36	4.73	4.04
COEF. OF DEV.	0.11	0.02	0.13	0.14	0.09

FIGURES IN WEEKS AFTER COMMISSIONING

TABLE X

REPAIR DOLLARS REMAINING CLASS AVE MODEL

	EFFECTIVENESS LEVEL				
	75%	80%	85%	90%	95%
USS LEFTWICH	40321	38999	19830	17847	5949
USS THORN	25779	25779	25779	25779	9915
USS FLETCHER	50236	42965	14542	14542	9915
MEAN	38779	35914	20050	19389	8593
STD. DEVIATION	12301	8999	5622	5775	2290
COEF. OF DEV.	0.32	0.25	0.28	0.30	0.27

FIGURES IN $ OF REPAIR REMAINING

TABLE XI

NINE MONTH W/G PERIOD (39 WEEKS) -CLASS AVE MODEL

SHIP	BUDGET COST	EST.BENE.	VARIANCE	ANALYSIS
USS LEFTWICH	$203000	$183758	$19242	UNFAVORABLE
USS THORN	203000	249858	46858	FAVORABLE
USS FLETCHER	203000	205571	2571	FAVORABLE
TOTAL	609000	639187	30187	FAVORABLE

Each ship in the class will have particular characteristics which will affect the way defective work will be discovered, and what defective work will be discovered. This in turn will affect the patterns of work discovery for that ship, and the total Warranty/Guaranty cost for that ship. These factors may be reduced in variance by uniform procedures and common, effective training on Warranty/Guaranty program management, but unique circumstances facing each ship will cause uncertainty in using average ship data as was done in this analysis. The authors recognize this problem, but feel that using average cost data in this case was still effective in highlighting possible areas of improvement in the Warranty/Guaranty program planning.

3. Non-quantifiables

In order to correctly make a decision about length of time for a Warranty/Guaranty period, considerations other than economic optimization must be analyzed. The primary non-quantifiable was driven by the ships' schedules after commissioning. Four key events seemed to drive the discovery of deficient work. These were (1) Commissioning; (2) Initial Shakedown; (3) Final Contract Trials; and (4) Post Shakedown Availability. Since the final event, Post Shakedown Availability, could not reasonably be scheduled before approximately the sixth month after commissioning (and the availability usually required approximately two to three months), Warranty/Guaranty coverage should not be less than eight months. This also allows the crew a reasonable period to operate the ship, and discover problems which might fall in the Warranty/Guaranty area.

H. CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions

Based on both quantifiable and unquantifiable information presented above, the following conclusions can be made:

(1) The twelve month Warranty/Guaranty program for the Spruance Class Destroyer was too lengthy.

(2) Too much money was set aside for Warranty/Guaranty items, since $42,000,000.00 was available, but only $8,119,347.00 was actually required.

2. Recommendations

Based on the model, the following recommendations are made:

(1) Nine months would be a more optimal length of time for any shipbuilding program of similar size, nature, and complexity as the Spruance Class Program. Based on the three samples, 90 percent effectiveness would have been achieved in all ships, with an average of only $9848 of repairs remaining to be handled by ship's crew. Also, the ships' initial one-year schedules would not have to be altered.

(2) The amount of money set aside for Warranty/Guaranty could be reduced to between 0.5 percent and 1.0 percent of target cost for the ships.

(a) The contract, as written, provided the following:

For 12 months at 2 percent of Target Cost =	$42000000
Actual Cost =	8119347
Excess Amount =	33880653

(b) If the Warranty/Guaranty period was reduced to nine months the following would have been provided using the same approach:

9/12 x 2% = 1.5% of Target Cost =	$31500000
Estimated Cost =	6090000
Excess Amount =	25410000

(c) If nine months at 1% Target Cost = $21000000

Estimated Cost = 6090000

Excess Amount = 14910000

(d) If nine months at 0.5% of Target Cost = $10500000

Estimated Cost = 6090000

Excess Amount = 4410000

With between four and fifteen million dollars in excess of what the model suggests is needed for the Warranty/Guaranty program, the Procurement Contracting Officer and Program Manager would have the necessary risk insurance available for the uncertainties of the shipbuilding program. Gross overestimation could be reduced.

(3) This model should serve only as an example of a lesson learned for the Spruance Class shipbuilding program. Its lessons may be applicable to length of Warranty/Guaranty periods for new shipbuilding programs, and negotiated amounts set aside for those programs. The study and judgement of Program Managers and Contracting Officers must still be the primary basis for decisions regarding new shipbuilding efforts.

IV. INTERNAL CONTROL

The purpose of this chapter is to analyze the internal control procedures utilized in the DD-963 Warranty/Guaranty program, identify any weaknesses and recommend changes that could improve future shipbuilding warranty programs.

The American Institute of Certified Public Accountants (AICPA) defines internal control as follows:

> "Internal control comprises the plan of organization and all of the coordinated methods and measures adapted within a business to safeguard its assets, check the accuracy and reliability of its accounting data, promote operational efficiency, and encourage adherence to prescribed management policies." [Ref. 4]

This definition describes systems used by management personnel in the maintenance of data base information from which they will learn and base future decisions. The system of internal control in the DD-963 Warranty/Guaranty program was established in most part by utilization of two existing Navy reporting systems. The Budget Operating Target (OPTAR) system was used to collect obligation information on material ordered and used in support of the program. The Maintenance and Material Management (3M) system was used to document and communicate discrepant work items and the number of manhours expended by Navy personnel in support of the program. The effectiveness of these systems will be reviewed in this chapter.

A. OPTAR REPORTING SYSTEM

The basic procedure used by the Navy to recoup Government funds expended in support of the Warranty/Guaranty program was discussed in Chapter II. Table XII contains the amount of money which the case study ships reported obligated via the Commanding Officers' closeout letters to the Supervisor of Shipbuilding. These figures were the amount SUPSHIP (Code 400) used as the basis for negotiation in settlement of contractor liability for Government furnished material and supplies in support of the Warranty/Guaranty program. The amount was a simple summation of the OPTAR balance in the special OPTAR account obligated by the ship until the end of the Warranty/Guaranty period. This procedure provided accurate obligation information as of the date of submission; however, due to the Navy accounting system and the basic difference between obligations and expenditures the procedure produced built-in anomalies.

An obligation is a legal reservation of funds whereas an expenditure is an actual disbursement in settlement of a government debt. Operating units order material and obligate funds to cover the estimated cost. As actual expenditures are made by paying activities in payment of the materials, the operating unit is informed by the accounting activity of the actual expenditure amount. This closes the loop and allows the operating unit to adjust its obligation amount

TABLE XII

MATERIAL EXPENDITURES

USS THORN	$7,241.15
USS LEFTWICH	$22,374.17
USS FLETCHER	$4,121.87

as necessary to bring its records into agreement with the actual amount of the expenditure.

No mechanism was employed to keep SUPSHIP (Code 400) informed of changes in OPTAR obligations. Because of the lag time in the accounting system this created the potential for significant error in the amount of money recouped from Ingalls in settlement of government furnished materials and services.

B. 3M REPORTING SYSTEM

The internal control mechanism utilized to document and communicate work items, and as a related issue manhours expended, was the 3M system as outlined in Chapter II. The authors initially intended to utilize the maintenance data base maintained by the Navy Maintenance Support Office (NMSO) as a major resource for this thesis. In theory, all 4790.2K's

written by fleet vessels are input to the data base and are available for review and study by Navy and government activities interested in studying maintenance related problems. A special report was designed by NMSO [Ref. 5]. The report was designed to sort maintenance actions by unit identification codes and the special purpose code block 46 where "WG" was to be placed on all Warranty/Guaranty 4790.2K's. The results of the effort were not satisfactory as only 2670 maintenance actions were retrieved of the 12,283 actually submitted to Ingalls warranty engineers (21.7 percent). After it was ascertained that the report was correctly prepared and no further improvement could be expected short of requesting an all inclusive report containing all maintenance actions for each unit identification code within a given timeframe, it was determined that it was simply not practical to utilize the data base as a resource. The reason for this discrepancy in reporting is addressed below.

The alternate method developed to obtain actual data was to secure contractor copies of the actual 4790.2K's submitted by three ships. Table XIII contains the number of manhours reported via the Commanding Officers' closeout letters of the case study vessels along with statistics taken from the contractor's copies of the actual 4790.2K's which were submitted. The manhour breakdown consists of the sum of the hours annotated in block 25, ship's force manhours expended, and block 27, ship's force manhours remaining, on all accepted

TABLE XIII

MANHOUR STATISTICS

	(1)	(2)	(3)	(4)	(5)	(6)
USS LEFTWICH	299	6	81	21	467	2720
USS THORN	429	31	129	31	2001	2418
USS FLETCHER	328	12	12	37	275	2959

(1) Number of 4790.2K's submitted.
(2) Number of 4790.2K's lost and unavaliable for review.
(3) Number of 4790.2K's rejected by Ingalls.
(4) Number of 4790.2K's accepted for material only.
(5) Number of manhours reported via closeout letter.
(6) Number of manhours annotated on 4790.2K's.

2K's not specifically annotated by the warranty engineer as 'material only". Table XIII also contains information on the disposition of the work items submitted.

There exists a significant spread in the figures submitted by the CO at warranty closeout and the figures tallied on the actual 2K's. After analysis this difference has been attributed to several factors:

1. Poor record keeping.
2. Work items accepted for material only, and
3. Negotiation of manhours by shipboard personnel.

1. Poor Record Keeping

There is little doubt that record keeping alone contributed to the spread in the figures in Table XII, columns

5 and 6. The fact that only 21 percent of the warranty work items could be retrieved from the NMSO data base indicates that substantial error was introduced into the system via inaccurate maintenance records keeping by shipboard personnel.

2. Materials Only Work Items

No provision was made in the contract articles for work items being accepted on a materials only basis. The case study statistics indicate 10.7 percent of all accepted work items were accepted with this caveat. This is a significant informal modification to the contract articles that was made at the shipboard level.

3. Negotiation of Manhours by Shipboard Personnel

Determination of fault for warranty items is difficult when so many variables are involved. Factors such as operator error, improper maintenance and consequential damage reach across a large "gray" area where judgement must be applied on the part of both shipboard and contractor personnel. These complexities forced both parties to seek middle ground on a number of work items. The middle ground utilized was the "material only" acceptance by Ingalls. Other impasses were solved by "horse trading" manhours for acceptance of work items that were disputable as to whether or not the contractor was at fault. These compromises were not found to be abused, but they were widely utilized to accommodate border-line work items and were clearly not provided for in the contract articles.

C. PRECOMMISSIONING CREW TRAINING

Internal control systems must be understood and utilized by managers if they are to be effective. The sophisticated crew training and phasing plan for the Spruance class destroyer program was developed and implemented to ensure that manpower assets were available and properly trained when required by the ship delivery schedule. Unfortunately, very little consideration was given in the extensive plan to providing supply and maintenance management personnel the requisite training required to understand the contract articles, their application, and the intricate process involved in the acceptance of a new construction ship for the Navy. The only formal training provided the precommissioning (PRECOM) crew was the two-hour Warranty/Guaranty lecture provided by SUPSHIP. The remainder of the learning process was to be conducted as on-the-job training. This lack of knowledge placed the PRECOM crew at a disadvantage working in a complex government and contractor management structure. The Commanding Officer was clearly charged with the responsibility of acceptance of the new construction ship. His success depended on his ability to articulate requirements via the proper channels and manage the efforts of people and organizations outside his normal chain of command. To facilitate this type of management effort a solid training program for ship's officers and chief petty officers is required.

As contained in Table XII the number of rejected work items, 222, amounted to 21 percent of the total discrepancies submitted. There were only two reasons for the rejection of these work items: either the work item involved government furnished material or it was considered to be routine maintenance and not a material failure. The repetitive submission of work items that clearly fell into these two categories indicates a low level of understanding of the Warranty/ Guaranty program by shipboard personnel. A cursory training program could have greatly improved the level of understanding of the PRECOM crew.

D. RECOMMENDATIONS

Internal control would be enhanced if the following mechanisms could be adjusted to communicate the required information to the proper manager in a timely fashion. The emphasis here is the correction of deficiencies, not the actual vehicle used. Each shipbuilding program is different in scope and the control systems will require individual structuring to meet the needs of the program.

The Supervisor of Shipbuilding should have available to him more timely information regarding the expenditure of government funds for warranty items. This could be accomplished any number of ways, such as including SUPSHIP in the reporting system or giving him the responsibility for the reimbursable fund instead of the type commander, but it is

absolutely necessary he have access to expenditure information in a timely fashion.

Provisions should be included in the contract vehicle to provide guidance regarding documentation of ship's force manhours expended and discrepancies accepted on a "material only" basis. These provisions should be written so as to grant the people on the waterfront the authority to come to terms with difficult work items and still be held accountable for their actions. By not addressing this issue, and hence allowing negotiation to occur between the ship and the Warranty Engineer without any guidance or review, no attempt to manage or maintain accountability is made.

The personnel training pipeline in the U.S. Navy for new construction ships is long and complex. That fact is recognized and no matter how much training is provided for a PRECOM crew, more could be justified. It is not the intent of this study to add to an already lengthy training pipeline; however, there was very little training provided the officers and crew on industrial management in a shipyard environment. It is essential that industrial management be understood by PRECOM personnel prior to the formation of the PRECOM crew. On-the-job training, or learning-by-mistakes is costly to the Navy as each PRECOM crew is formed of itself, and no corporate knowledge exists to guide crew members. This oversight allows the same problems to occur over and over on each ship without benefit of learning.

E. SUMMARY

The internal control system established and used in the DD-963 program using established Navy reporting routines was flexible, and encouraged adherence to management policy. However, the system did not provide the ACO with timely expenditure information nor did it provide the adequate flexibility and guidance that was required by shipboard personnel who were involved in actual negotiations regarding work item acceptance and government material and manhours expended. The system could be used as a model for future shipbuilding programs, providing the system shortcomings identified above are corrected. Caution is advised when using any control system as a model; control systems should be tailored expressly for the individual program, taking into consideration the program's own intricacies and the reporting requirements of the program managers involved.

V. CONCLUSIONS AND RECOMMENDATIONS

There are many issues confronting the Program Manager and Procurement Contracting Officer when making decisions about major shipbuilding programs. After reviewing just one, the Warranty/Guaranty decision, it appears that several lessons emerge. Conclusions are presented first, followed by recommendations.

A. CONCLUSIONS

1. The nature of modern military shipbuilding requires a mechanism for extension of contractor liability beyond the initial delivery date. Quality assurance and acceptance testing must be performed under actual conditions. Defective material and workmanship should be the responsibility of the contractor and the Government should have the right to assert claims regarding defects discovered after acceptance of the ship.

2. The DD-963 shipbuilding program represented a new contracting approach wherein design, engineering, construction and fleet readiness were all provided by a single contractor under a fixed-price incentive contract for a total of 30 modern destroyers. Lessons learned should, therefore, be applicable to shipbuilding efforts conducted under similar conditions of uncertainty and contract structure. Plans for

future shipbuilding efforts could incorporate lessons learned from this effort.

3. Even though the DD-963 shipbuilding contract was not executed totally as planned, and many problems arose during its execution which severely changed the basic contract structure, the Warranty/Guaranty effort was executed as originally conceived.

4. The management control techniques used by the ship during the Warranty/Guaranty period were the same used in normal fleet operations. The coordination between the Navy commands involved in the administration of the program was well defined and utilized the existing Navy 3M, Supply, and CASREP reporting systems to document and communicate problems that were identified. This maintained extra reporting requirements at a minimum.

5. Review of the Warranty/Guaranty effort was held on a timely basis, which allowed problems to be resolved and agreement to be gained on an incremental basis without overburdening the ship's crew.

6. The primary objectives of a Program Manager are to get a new ship delivered at or under contract cost targets, on or before required delivery date, with the minimum possible defects still in existence after acceptance by the Government. A specific Warranty/Guaranty coverage period is the best method available to achieve this, assuming no additional efficiency in inspection procedures can be achieved in the

short run, and that defective material and workmanship items will exist at time of delivery due to the complexity of the shipbuilding process.

7. The economic objective for deciding the length of time a Warranty/Guaranty program should run is to correct as much defective material and workmanship existing at the time of delivery, up to the point where the marginal benefits obtained from correction at least equal the marginal costs for the Warranty/Guaranty clause being extended an additional increment of time.

8. The twelve month Warranty/Guaranty program for the Spruance Class Destroyer shipbuilding program was too lengthy. Too much money was set aside for Warranty/Guaranty items in the initial contract, indicating an overestimation of the production uncertainties and technical problems which were actually encountered during the program.

9. No mechanism was employed in the Budget Operating Target (OPTAR) System to keep the SUPSHIP Code 400 (Administrative Contracting Officer) informed of changes in OPTAR obligations. The lag in the accounting system between obligation and actual expenditure data created the potential for significant error in the amount of money recovered in settlement of government furnished materials and services.

10. The Maintenance and Material Management (3M) System did not effectively capture data pertaining to the Warranty/Guaranty efforts of each Spruance Class ship. Only 2670

maintenance actions were retrieved from the data base at Fleet Material Support Office (FMSO) out of the actual 12,283 submitted to Ingalls warranty engineers. This was a poor 21.7 percent effectiveness.

11. Poor record keeping, work items accepted for material only, and negotiation of manhours by shipboard personnel caused a significant spread in the figures submitted by the CO at Warranty closeout from those actually recorded on discrepancy 2K's. This in turn caused a material misstatement of funds actually expended by the Navy under the Warranty/Guaranty clause, and reimbursable to the Navy by Ingalls.

12. Very little consideration was given in the extensive crew training and phasing plan for the Spruance class destroyer program for providing supply and maintenance management personnel with the requisite training required to understand the Warranty/Guaranty contract article, its implications, and the intricate process involved in accepting a new ship for the Navy.

B. RECOMMENDATIONS

1. Nine months would be a more optimal length of time for any shipbuilding program of similar size, nature, and complexity to the Spruance Class program. The ship's first year schedule could remain intact, and effectiveness in correcting deficient material and workmanship would remain at no less than 90 percent of that achieved after running the program for one year.

2. The amount of money set aside for Warranty/Guaranty items could be reduced to between 0.5 percent and 1.0 percent of target cost for shipbuilding programs of a similar complexity rather than the 2 percent thumbrule used in the Spruance class contract.

3. The Administrative Contracting Officer (in this case Supervisor of Shipbuilding) should have available to him more timely information regarding the expenditure of government funds for warranty items. This could be accomplished by including the ACO in the reporting system, or giving him the responsibility for the reimbursable fund rather than the Type Commander. In any case, the expenditure information absolutely must be made available to the ACO in a timely manner.

4. Provisions should be included in the contract to provide guidance regarding documentation of ship's force manhours expended and discrepancies accepted on a "Materials Only" basis. These provisions should give responsible agents on the waterfront the authority to resolve issues arising from difficult work item responsibilities, and still ensure accountability for their actions. Allowance of negotiations between the ship and warranty engineer without any guidance or review caused a loss of efficiency and accountability on the part of the Government for money available for recovery under the Warranty/Guaranty clause.

5. It is essential that better training on industrial management in the shipyard be afforded PRECOM crews. On-the-job training which occurred on the Warranty/Guaranty program did not provide the level of knowledge necessary to ensure efficient, effective discovery, documentation, reporting, and resolution of issues arising under the Warranty/Guaranty program.

6. These lessons learned may be applicable to shipbuilding efforts in the future. The study and judgement of Program Managers and Contracting Officers must still be the primary basis for decisions regarding these new shipbuilding projects.

APPENDIX A
WARRANTY/GUARANTY CONTRACT ARTICLES

The provisions of the DD-963 contract which provided for the Warranty program are contained in the following articles taken from the actual contract.

ARTICLE XI. PERFORMANCE, MAINTAINABILITY, AND RELIABILITY GUARANTEE

(a) The parties have agreed that when the first acceptable vessel (hereinafter referred to as the product Baseline Vessel) has been delivered to the Government (at which time Guarantee and Warranty commence) and has successfully completed its Final Contract Trials, all other vessels will be constructed in strict conformity to that Product Baseline, except for any changes therein which may be made in accordance with this contract. The contractor guarantees that, notwithstanding inspection and delivery of the vessels covered by this guarantee, it will at its own expense correct any design and engineering deficiencies in each of the vessels, provided, however, that the Plans for Maintenance are complied with, and provided further that the causes of any such deficiencies or excess maintenance are attributable to improper design or engineering and not to human error or negligence. The guarantee shall continue during the period from delivery to Final Acceptance

of the fifth vessel. As used in this Article, design and engineering deficiencies shall include deficiencies or failures in the vessel(s) which result in the failure of a system, subsystem or component to perform in accordance with the Contract Specifications.

(b) Notwithstanding inspection and Final Acceptance by the Government of each of the vessels constructed and delivered under this contract, or any provision of this contract concerning conclusiveness thereof, the Contractor guarantees that for a period of forty-eight (48) months after final acceptance of the fifth vessel, each such vessel will perform in accordance with the Contract specifications of this contract.

(c) The Contracting Officer shall give written notice to the Contractor of any breach of the guarantees in paragraphs (a) and (b) of this clause within thirty (30) days of such breach. The Government shall have the option of either correcting the condition aboard the vessel at its location, having the condition corrected at the nearest repair yard to the vessel's location, or, whenever the condition will not interfere with the continued operation of the vessel, having the vessel returned to the Contractor's shipyard for correction of the condition. In the event such condition requires immediate correction, in order to continue the safe operation of the vessel, the Government shall notify the Contractor within five (5)

days after the discovery of the condition and before repair, if practicable.

(d) Within a reasonable time after such notice, the Contracting Officer may either:

(i) by written notice require the prompt correction or replacement of any supplies or part thereof by the Contractor;

(ii) have the corrections or replacements made by a source other than the Contractor and charge the cost thereof to the Contractor. When corrective action is taken at a location other than the Contractor's yard, opportunity shall be given to a representative of the Contractor to inspect the deficiency and observe its repair, if practicable. When such corrective action is taken, due to emergency conditions or due to election by the Government at a location other than the Contractor's yard, an invoice shall be furnished to the Contractor for services rendered and shall be duly certified by the Government that:

(1) All such corrections are deemed to be the responsibility of the Contractor under this Article;

(2) All such corrections were performed under emergency conditions or under circumstances where Contractor personnel were not readily available;

(3) A copy of all data available to the Government concerning such corrections has been made available to the Contractor or will be made available upon request;

(4) Payment has been made by the Government for all such corrections.

Promptly upon receipt of any such invoice from the Contracting Officer, the Contractor shall either pay the amount due, subject, however, to the "Disputes" clause of this contract or shall negotiate the amount due with the Contracting Officer.

(e) The Contractor may, at its own expense, maintain on board each Destroyer covered by this guarantee, a guarantee engineer who shall be afforded every reasonable opportunity to inspect such vessel in all its parts except for such areas as may be restricted because of military security. Such guarantee engineer shall have no power to direct or control the operation of said vessel or vessels. In the event a guarantee engineer decides that maintenance procedures are not being accomplished or that operating procedures in use will in any way void any part of this guarantee, he shall immediately notify the Commanding Officer of the ship, the Contracting Officer, and the Project Manager, Washington, D.C. A guarantee engineer may be furnished under the provisions of this ARTICLE XI or the provisions of ARTICLE XII, but not both.

(f) The liability of the Contractor under this guarantee is limited to corrections to the vessels as herein provided, and consequential or special damages are expressly excluded. The provisions of this Article shall not be applicable to:

(i) Government-furnished equipment, materials, and supplies, except the installation thereof;

(ii) accidents, misuse, abuse, improper operational procedures, or negligence by non-Contractor personnel;

(iii) repairs, correction, replacements, alterations, or additions by a source other than the Contractor, except under emergency conditions as herein provided;

(iv) damage caused by perils of the sea, rivers, or navigation or by exposure to unreasonable environmental conditions;

(v) replacement of DD-963 components in accordance with the Maintenance Plan;

(vi) deficiencies caused by failure of the Government to perform maintenance in accordance with the Plans for Maintenance.

(g) The maximum and sole liability of the Contractor under this guarantee article and the warranty provisions (ARTICLE XII) of this contract shall be limited to $42,798,000.00 "...which amount includes, but is not limited to, the cost of providing guarantee and warranty engineers and support for administering the Contractor's obligations under ARTICLES XI, XII, and XXII of this contract, provided that no more than $900,000.00 for guarantee and warranty engineers and support shall be included in the aforesaid $42,798,000.00 (added by p00064)".

(h) The rights and remedies of the Government provided in this clause are in addition to and do not limit any rights afforded to the Government by any other clause of the contract.

ARTICLE XXII. CONTRACTOR PERSONNEL (WARRANTY ENGINEERS)

(a) The Contractor may retain representatives (hereinafter called "warranty engineers") to provide the Government with expert services in connection with "Article XI-Performance, Maintainability, and Reliability Guarantee, and Article XII, Warranty Period, hereunder.

(b) The Contractor shall be responsible for selecting personnel who are well qualified to perform the required services; to supervise techniques used in operating the ships; and to inform the parties of improvements in methods of ship operations.

(c) Contractor personnel, upon assignment, either within the continental limits of the United States or overseas, are subject to call 24 hours a day. Normally, they will perform their assigned duties on the same daily and hourly basis as the ship's company to which they are assigned. Holidays will be observed in accordance with the direction of the Commanding Officer of the vessel to which Contractor personnel are assigned.

(d) The Contractor may furnish a replacement for any Contractor personnel who may be returned to the Contractor's plant or become incapacitated, or die, or otherwise be unable to complete performance hereunder prior to the expiration of the period of performance, unless otherwise agreed upon by the parties hereto.

(e) The Contractor shall furnish all necessary equipment, salaries and wages of its personnel, all costs of subsistence and lodging, cost of passports, insurance, and and all other costs in connection with the services to be rendered except as otherwise provided in ARTICLE XXIV, hereof, entitled SERVICES FURNISHED BY THE GOVERNMENT (WARRANTY ENGINEERS).

(f) The Contractor shall furnish in writing to the Contracting Officer the name of each person assigned by the Contractor under this contract, his qualifications, his security clearance, and such other pertinent information as the Contracting Officer may request. The Contractor shall have the right to replace or transfer its personnel and to substitute other qualified personnel in lieu thereof; provided, however, that such replacements or transfers have been coordinated with the Contracting Officer. Any transfers or reassignments shall be at the Contractor's expense.

(g) The Contracting Officer may, if he finds it to be in the best interest of the Government, direct the Contractor to remove, and the Contractor shall remove, any employee from an assignment to perform services under this contract.

(h) The Contractor shall furnish to and file with the Contracting Officer copies of records of employment of such warranty engineers.

(i) Personnel employed by the Contractor hereunder and sent overseas shall be accredited to the United States Navy with a recognized status under the Hague Regulations and the Geneva Covenants, shall be given proper credentials and identification cards, shall wear a uniform when prescribed by the Theater Commander, shall be subject to appropriate recognition under the rules of war, and shall be subject to such regulations as have been or may hereafter be issued by the United States Navy governing Contractor personnel serving with the United States Navy in foreign theaters of operation.

ARTICLE XXIII. CAPTURE AND DETENTION

(a) As used in this clause:

(1) "captured person" means any employee of the Contractor-

(i) who is assigned to duty outside the United States for the performance of this contract, and

(ii) who is found to be missing from his place of employment under circumstances that make it appear probably that his absence is due to the action of the force of any power not allied with the United States in a common military effort, or who is known to have been taken prisoner, hostage or otherwise detained by the force of any such power, whether or not such person is actually engaged in his employment at the time of capture; provided that at the time the person was captured and detained that the person was either;

(A) engaged in activity directly arising out of the course of his employment under this contract, or

(B) captured in an area in which the captured person was present only because such presence was required in order to perform this contract;

(2) a "period of detention" begins with the day of capture and continues until the captured person is returned to his place of employment, or to the United States, or until his death is in fact established or legally can be presumed to have occurred by evidence satisfactory to the Contracting Officer, whichever shall occur first;

(3) "United States" comprises geographically the fifty states and District of Columbia;

(4) "War Risk Hazards Compensation Act" refers to the statute compiled in Chapter 12 of Title 42 U.S. Code (Sections 1701-1717), as amended.

(b) If pursuart to an agreement entered into prior to the capture, the Contractor is obligated to pay and shall have paid benefits to a captured person, or his dependents, on account of his detention, the Government will reimburse the Contractor for such payments up to an amount which will equal the lesser of:

(i) the total wage or salary (computed at the rate being paid at the time of capture) due from the Contractor to the captured person for the period of detention, or

(ii) that amount which would have been payable to such person if the detention had occurred under circumstances wherein the benefit provisions of the War Risk Hazards Compensation Act would have been applicable.

(c) The period of detention shall not be considered as time spent in the performance of this contract, and the Government shall not be obligated to make payment under this contract on account of such person for the period of the detention except as provided in this clause.

(d) The obligation of the Government to make payments provided for by this clause shall be applicable to the entire period of detention except that it is expressly conditioned upon and subject to the availability of funds from which payment can be made. The rights and obligations of the parties under this clause shall survive the earlier expiration, completion or termination of this contract.

(e) The Contractor shall not be reimbursed under the provisions of this clause for payments made to employees for a period of detention during which the employees were entitled to compensation for capture and detention under the War Risk Hazards Compensation Act, as amended.

ARTICLE XXIV. SERVICES FURNISHED BY THE GOVERNMENT (WARRANTY ENGINEERS)

In connection with services of warranty engineers to be rendered here-under, the Government shall furnish and supply to the Contractor the following facilities and services:

(a) Use of Government communication facilities for the exchange of messages between Contractor personnel and the Contractor, where and when available if the Contractor is unable to procure commercial communication services; but the use thereof shall be subject to the regulations of the representatives of the Government in charge thereof.

(b) Use of Government services and agencies in the transmittal of funds to Contractor personnel and as medium of commercial exchange for said personnel when adequate commercial services and facilities are not available.

(c) Contractor personnel assigned to DD-963 Class destroyers will be accorded the same privileges as commissioned officers with regard to quarters, local transportation and messing, when available. Emergency medical services may be furnished as prescribed by applicable regulations. [Ref. 2]

APPENDIX B
CHAPTER III TABLES

WORK ITEMS SUBMITTED AND TOTAL EXPENDITURES

HULL	NAME	NO. 2K's	EXPENDITURES
DD-963	SPRUANCE	431	$1,217,134.62
DD-964	PAUL F FOSTER	1083	846,250.92
DD-965	KINKAID	560	660,564.32
DD-966	HEWITT	521	547,938.67
DD-967	ELLIOT	448	406,810.58
DD-968	ARTHUR RADFORD	384	346,782.34
DD-969	PETERSON	395	219,250.48
DD-970	CARON	384	113,434.42
DD-971	DAVID RAY	581	544,747.28
DD-972	OLDENDORF	467	141,360.35
DD-973	JOHN YOUNG	499	152,209.91
DD-974	COMTE DE GRASSE	486	156,246.49
DD-975	O'BRIEN	286	395,323.76
DD-976	MERRILL	425	194,118.46
DD-977	BRISCOE	184	129,270.58

CONTINUED ON NEXT PAGE

WORK ITEMS AND EXPENDITURES (CONTINUED)

HULL	NAME	NO.2K's	EXPENDITURES
DD-978	STUMP	257	103,590.99
DD-979	CONOLLY	289	336,347.96
DD-980	MOOSBRUGGER	295	133,204.15
DD_981	JOHN HANCOCK	206	106,231.57
DD-982	NICHOLSON	238	89,342.48
DD-983	JOHN ROGERS	378	100,583.31
DD-984	LEFTWICH	299	160,489.76
DD-985	CUSHING	337	122,820.98
DD-986	HARRY W HILL	246	183,003.78
DD-987	O'BANNON	613	127,422.43
DD-988	THORN	429	105,637.27
DD-989	DEYO	241	75,366.37
DD-990	INGERSOLL	473	131,400.33
DD-991	FIFE	516	194,821.47
DD-992	FLETCHER	328	77,640.58

USS LEFTWICH DD-984 WORK ITEM ACCUMULATION BREAKDOWN

WEEK	FREQUENCY	CUM. FREQUENCY	% OF TOTAL
1	17	17	5.7
2	28	45	15.1
3	11	56	18.79
4	11	67	22.48
5	12	79	26.51
6	11	90	30.20
7	4	94	31.54
8	5	99	33.22
9	11	110	36.91
10	7	117	39.91
11	8	125	41.95
12	8	133	44.63
13	9	142	47.65
14	5	147	49.33
15	2	149	50.00
16	0	149	50.00
17	11	160	53.69
18	11	171	57.38
19	10	181	60.74
20	5	186	62.42
21	2	188	63.09
22	8	196	65.77
23	2	198	66.44
24	7	205	68.79
25	6	211	70.81
26	8	219	73.49

CONTINUED ON NEXT PAGE

USS IEFTWICH WORK ITEMS (CONTINUED)

WEEK	FREQUENCY	CUM. FREQUENCY	% OF TOTAL
27	10	229	76.85
28	5	234	78.52
29	3	237	79.53
30	2	239	80.20
31	3	242	81.21
32	3	245	82.21
33	6	251	84.53
34	5	256	85.91
35	6	262	87.92
36	5	267	89.60
37	1	268	89.93
38	3	271	90.94
39	7	278	93.29
40	1	279	93.62
41	1	280	93.96
42	0	280	93.96
43	1	281	94.30
44	0	281	94.30
45	6	287	96.31
46	2	289	96.98
47	0	289	96.98
48	0	289	96.98
49	4	293	98.32
50	1	294	98.66
51	2	296	99.33
52	2	298	100.00

USS THORN DD-984 WORK ITEM ACCUMULATION BREAKDOWN

WEEK	FREQUENCY	CUM. FREQUENCY	% OF TOTAL
1	42	42	10.40
2	44	86	21.29
3	13	99	24.50
4	8	107	26.49
5	8	115	28.47
6	5	120	29.70
7	7	127	31.44
8	2	129	31.93
9	12	141	34.90
10	2	143	35.40
11	5	148	36.63
12	5	153	37.87
13	4	157	38.86
14	17	174	43.07
15	26	200	49.50
16	11	211	52.23
17	13	224	55.45
18	18	242	59.90
19	21	263	65.10
20	17	280	69.31
21	8	288	71.29
22	2	290	71.78
23	7	297	73.51
24	7	304	75.25
25	9	313	77.48
26	18	331	81.93

CONTINUED ON NEXT PAGE

USS THORN WORK ITEMS (CONTINUED)

WEEK	FREQUENCY	CUM. FREQUENCY	% OF TOTAL
27	13	344	85.15
28	18	362	89.60
29	3	365	90.35
30	4	369	91.54
31	2	371	91.83
32	2	373	92.33
33	1	374	92.57
34	0	374	92.57
35	2	376	93.07
36	0	376	93.07
37	1	377	93.32
38	0	377	93.32
39	1	378	93.56
40	1	379	93.81
41	0	379	93.81
42	0	379	93.81
43	1	380	94.06
44	2	382	94.55
45	4	386	95.54
46	3	389	96.29
47	5	394	97.52
48	10	404	100.00
49	0	404	100.00
50	0	404	100.00
51	0	404	100.00
52	0	404	100.00

USS FLETCHER DD-992 WORK ITEM ACCUMULATION BREAKDOWN

WEEK	FREQUENCY	CUM. FREQUENCY	% OF TOTAL
1	38	38	11.66
2	56	94	28.83
3	22	116	35.58
4	31	147	45.09
5	7	154	47.24
6	5	159	48.77
7	5	164	50.31
8	4	168	51.53
9	6	174	53.74
10	13	187	57.36
11	17	204	62.58
12	1	205	62.88
13	0	205	62.88
14	9	214	65.64
15	3	217	66.56
16	1	218	66.87
17	1	219	67.18
18	3	222	68.10
19	1	223	68.40
20	4	227	69.63
21	4	231	70.86
22	3	234	71.80
23	5	239	73.31
24	11	250	76.69
25	1	251	77.00
26	4	255	78.22

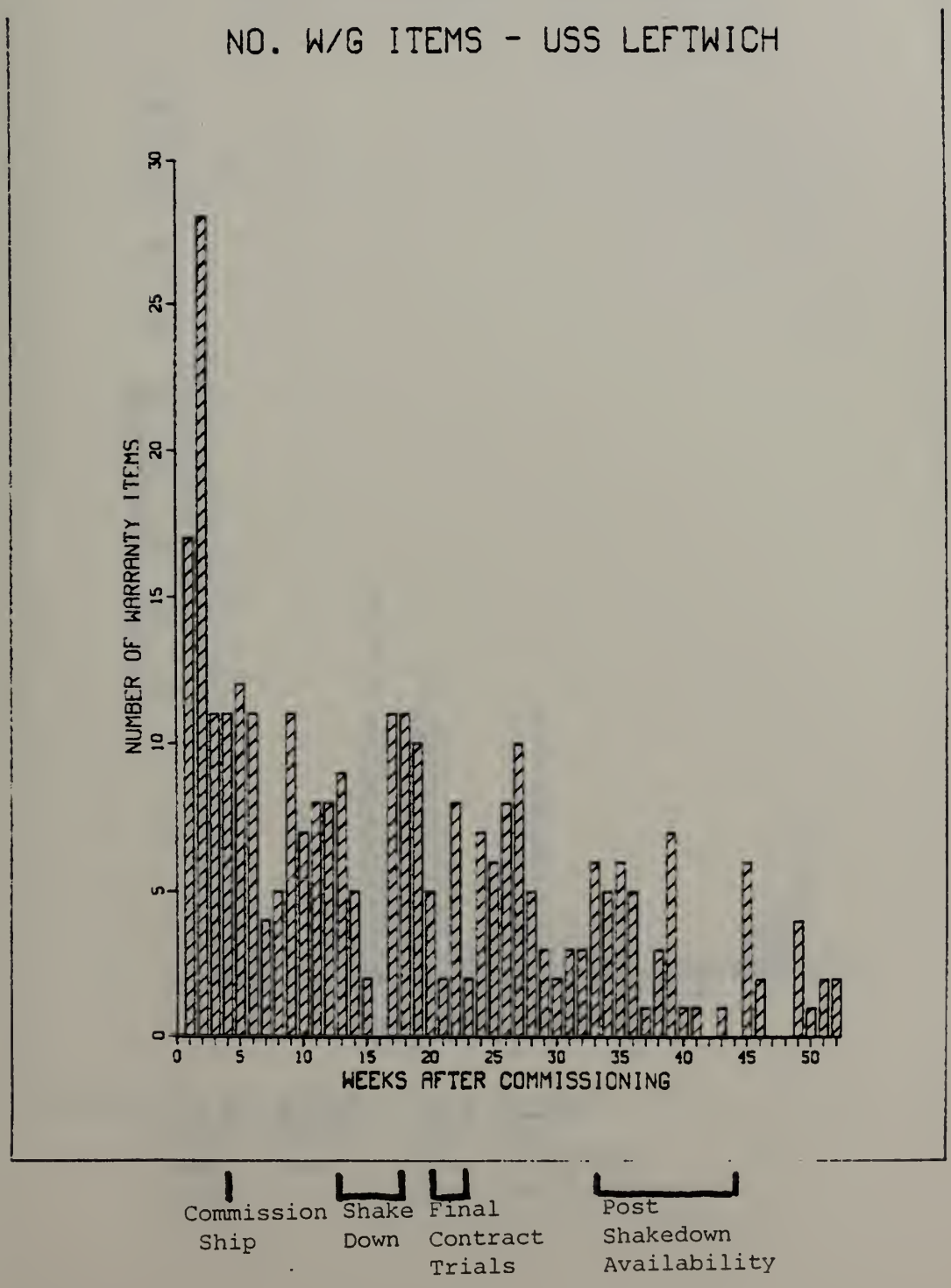
CONTINUED ON NEXT PAGE

USS FLETCHER WORK ITEMS (CONTINUED)

WEEK	FREQUENCY	CUM. FREQUENCY	% OF TOTAL
27	3	258	79.14
28	0	258	79.14
29	3	261	80.06
30	3	264	80.98
31	10	274	84.05
32	1	275	84.36
33	11	286	87.73
34	11	297	91.10
35	6	303	92.94
36	1	304	93.25
37	4	308	94.48
38	1	309	94.79
39	2	311	95.40
40	2	313	96.01
41	3	316	96.93
42	3	319	97.85
43	1	320	98.16
44	5	325	99.69
45	0	325	99.69
46	1	326	100.00
47	0	326	100.00
48	0	326	100.00
49	0	326	100.00
50	0	326	100.00
51	0	326	100.00
52	0	326	100.00

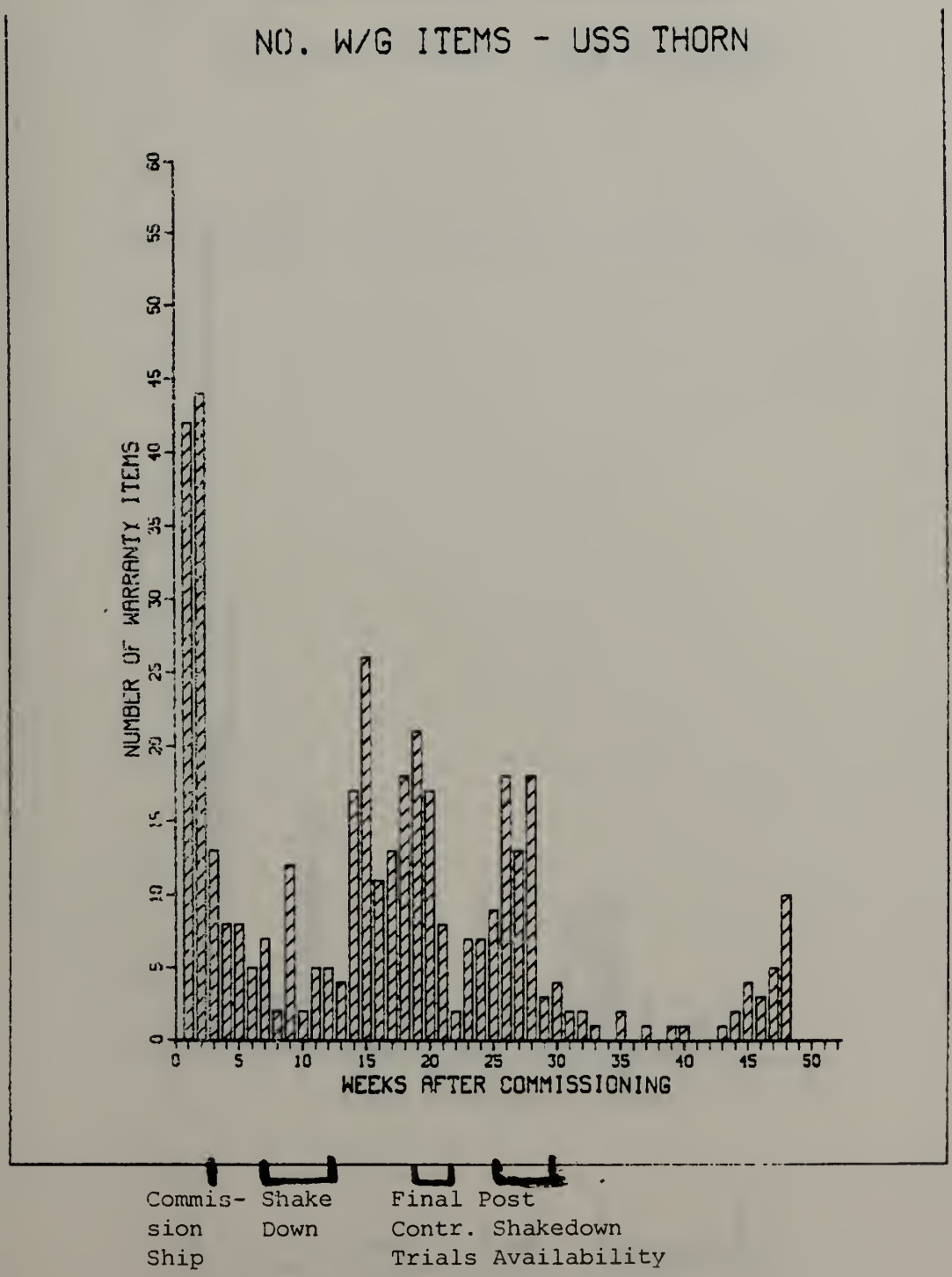
APPENDIX C

NO. W/G ITEMS - USS LEFTWICH



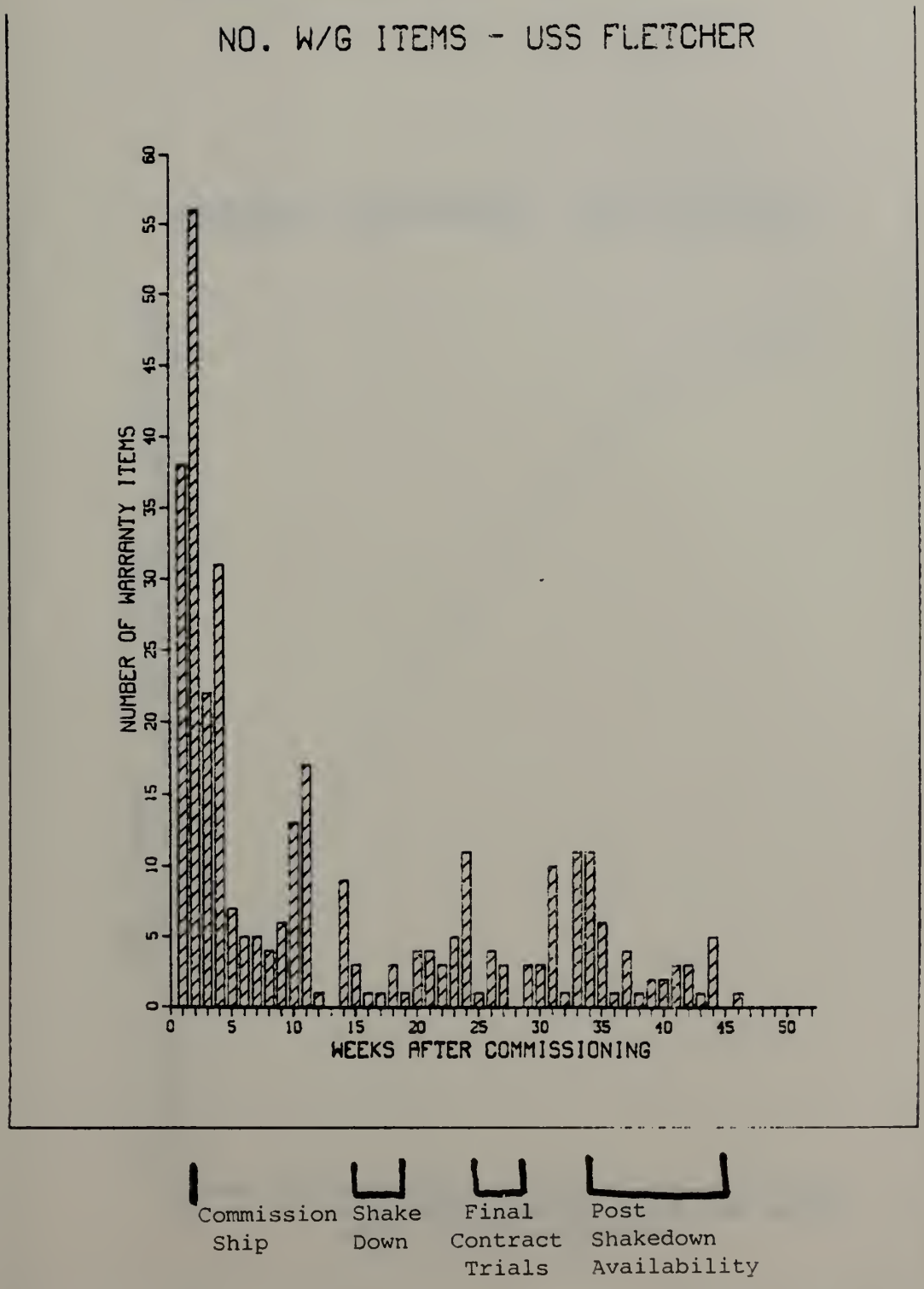
APPENDIX D

NO. W/G ITEMS - USS THORN



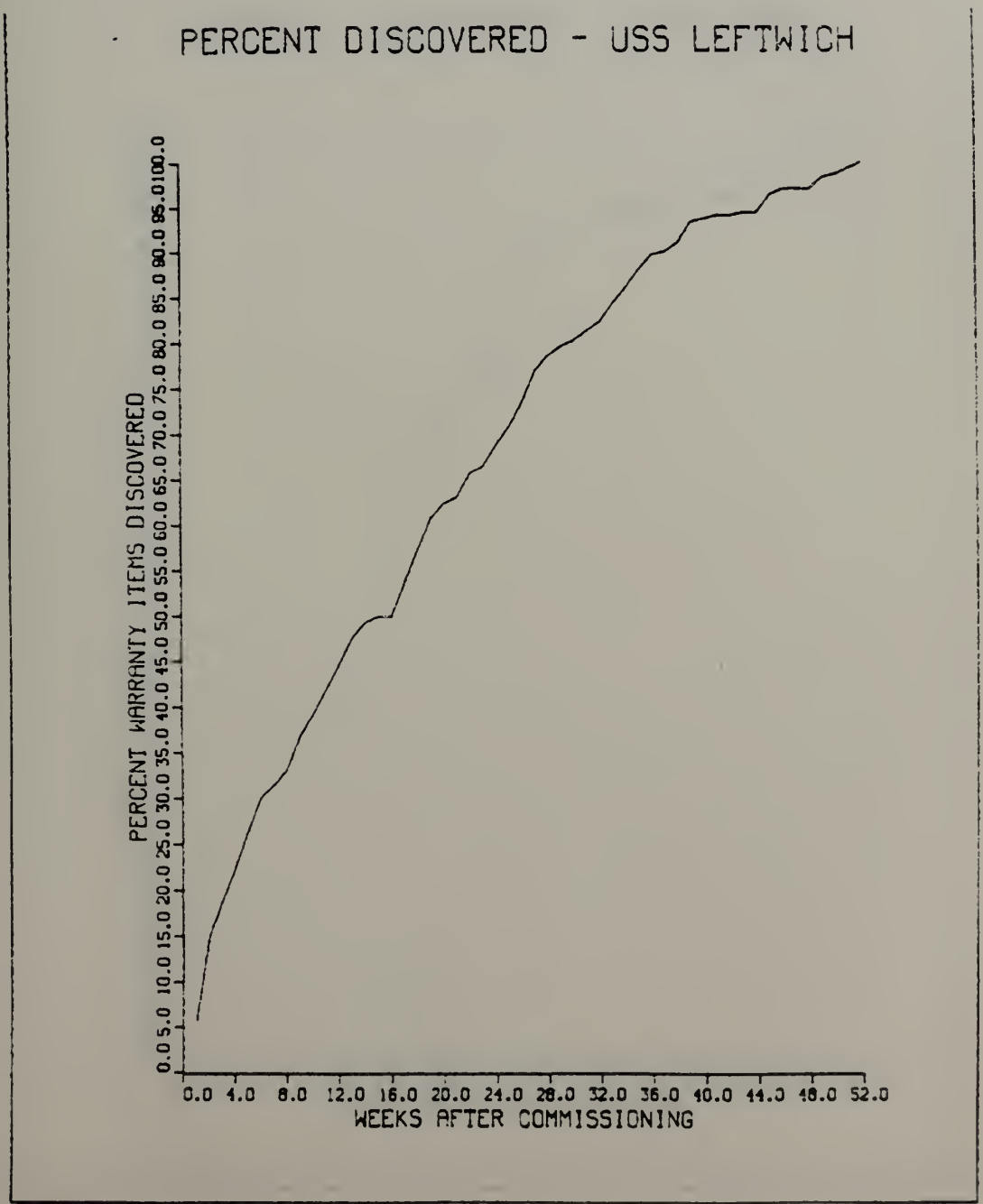
APPENDIX E

NO. W/G ITEMS - USS FLETCHER



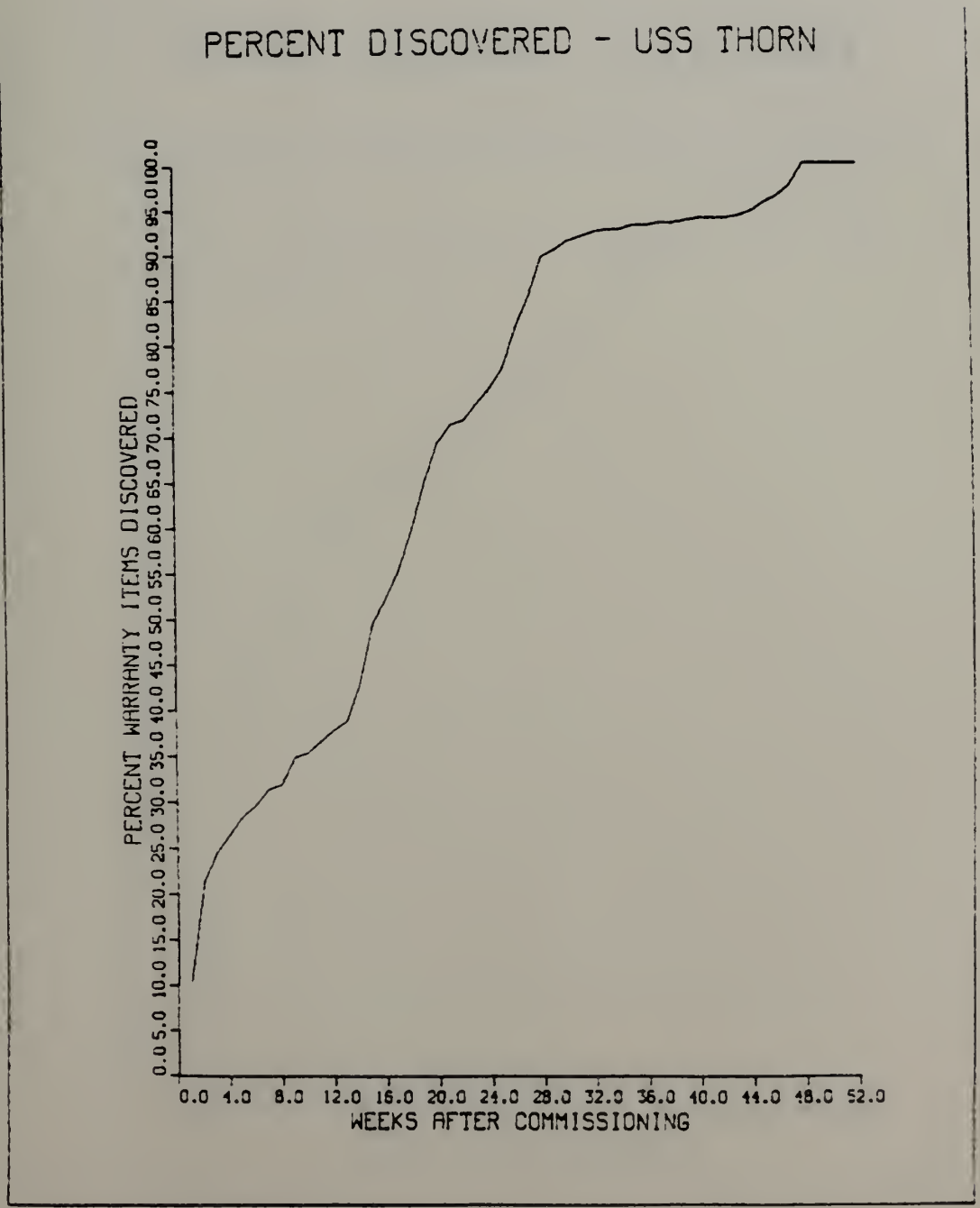
APPENDIX F

PERCENT DISCOVERED - USS LEFTWICH



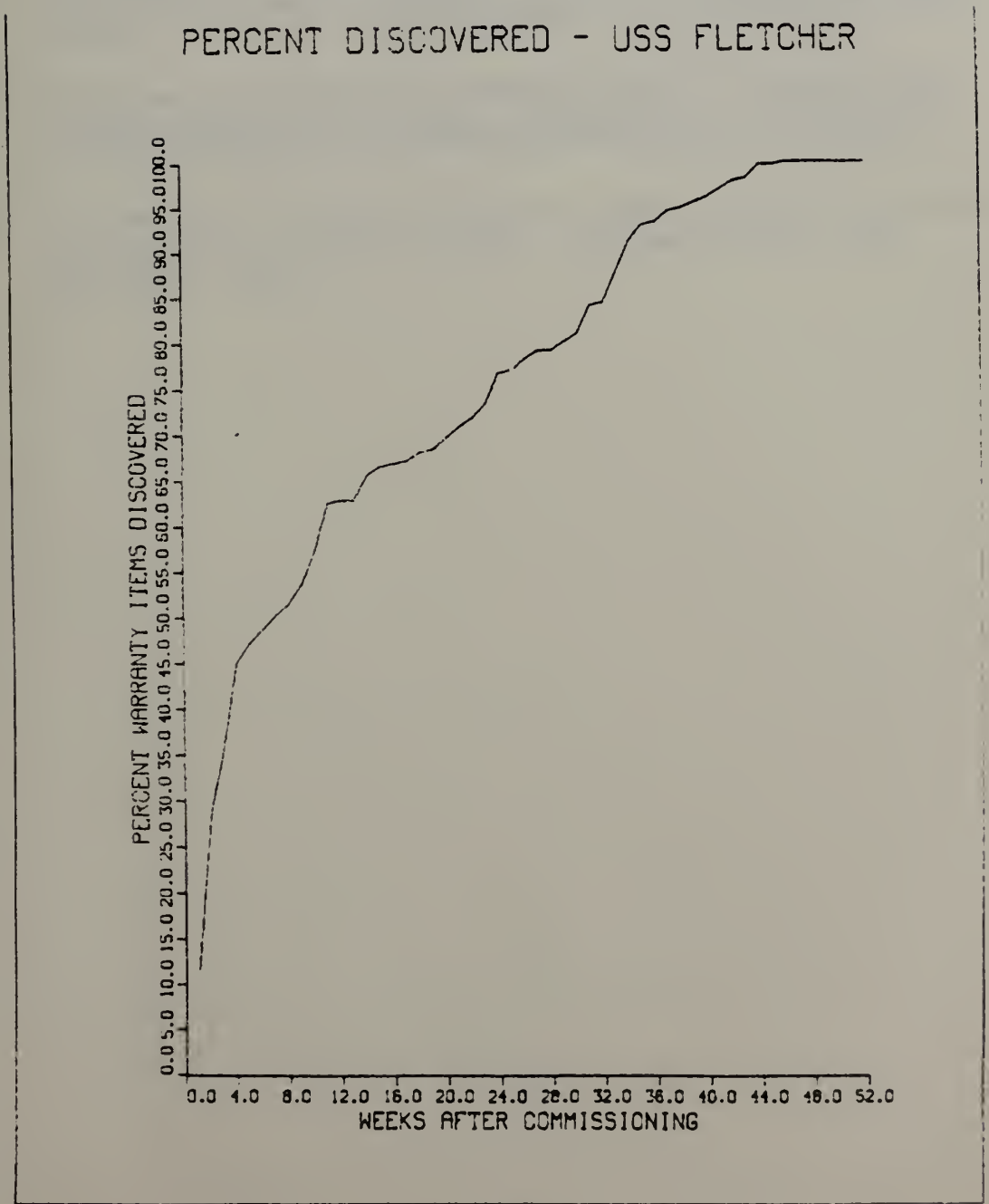
APPENDIX G

PERCENT DISCOVERED - USS THORN



APPENDIX H

PERCENT DISCOVERED - USS FLETCHER



LIST OF REFERENCES

1. Armed Services Procurement Regulation, para 1-324.

2. Department of the Navy, Naval Ship Systems Command, Contract number N00024-70-C-0275, 1970.

3. Supervisor of Shipbuilding, Conversion, and Repair Pascagoula, Ms. Warranty Guaranty Information Book, 1975.

4. Statement on Auditing Standards No. 1, Section 320, Codification of Auditing Standards and Procedures, AICPA, 1965.

5. Fulkerson, P., special report number SS-83-136, Navy Maintenance Support Office. Mechanicsburg, Pa., November 1982.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Technical Information Center Cameron Station Alexandria, Virginia 22314	2
2.	Library, Code 0142 Naval Postgraduate School Monterey, California 93940	2
3.	Defense Logistics Studies Information Exchange U.S. Army Logistics Management Center Fort Lee, Virginia 23801	1
4.	Department Chairman, Code 54 Department of Administrative Sciences Naval Postgraduate School Monterey, California 93940	1
5.	Naval Sea Systems Command Code 02 Department of the Navy Washington, D.C. 20376	1
6.	Naval Air Systems Command Code 02 Department of the Navy Washington, D.C. 20376	1
7.	LCDR James Timothy Freihofer Naval Sea Systems Command PMS-406C Department of the Navy Washington, D.C. 20362	3
8.	LT Daniel S. Beach 31 Montsalas Drive Monterey, California 93940	3
9.	Asst. Prof. D. C. Boger, Code 54Bk Department of Administrative Sciences Naval Postgraduate School Monterey, California 93940	1

10. LCDR J. R. Bergquist, Code 54Za 1
Department of Administrative Sciences
Naval Postgraduate School
Monterey, California 93940

NOV - 8 1995
FEB 19
NOV 10 1995
NOV 13 1995
NOV 14 1995
NOV 15 1995

200406

Thesis
F799
c.1

Freihofer
The warranty guaranty clause: an analysis of its use on the Spruance class (DD-963) ship-building contract and identification of les-sons learned.

thesF799
The warranty guaranty clause :
3 2768 001 90023 6
DUDLEY KNOX LIBRARY